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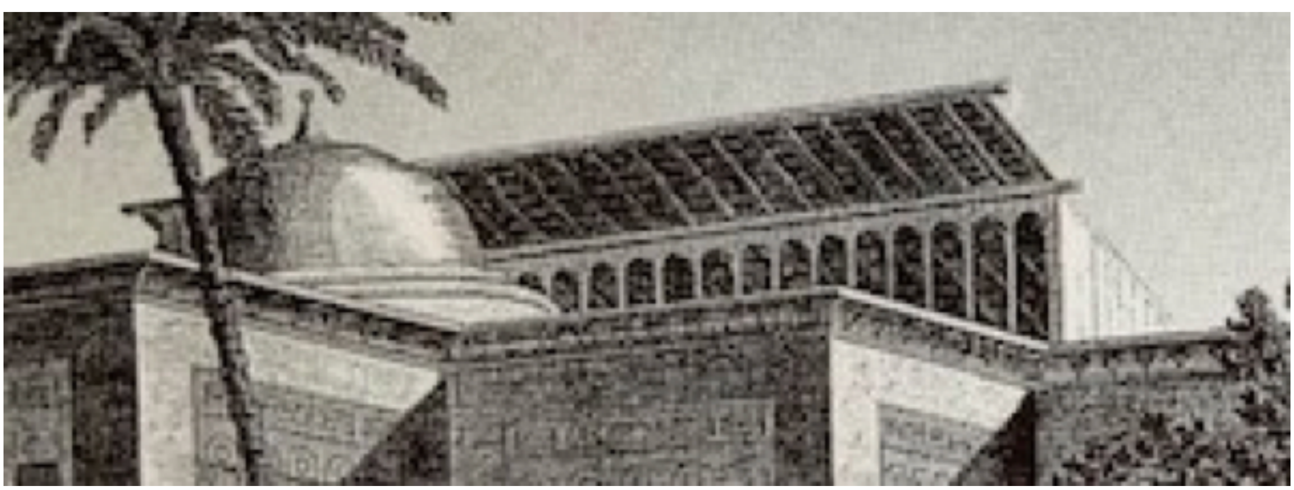
The wind-catchers of medieval Cairo and their secrets

1001 years of renewable energy

This work is in two parts.
Part I, presented here, contains an overview of the historical sources.
Part II contains the illustrations.

The wind-catchers of medieval Cairo and their secrets

1001 years of renewable energy



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For Patricia,

Max & Adrian,

and Kayen

Key-words:

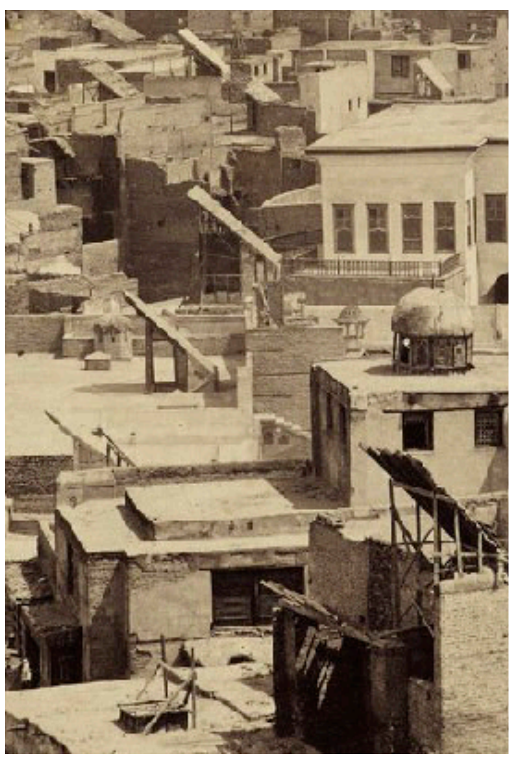
Cairo, Egypt, Baghdad, medieval, Fatimid, Ayyubid, Mamluk, Ottoman, architecture, history of Islamic architecture, Cairo architecture, Damascus, Aleppo, domestic architecture in medieval Cairo, mosques, vernacular, ventilators, ventilation, wind-catchers, wind-scoops, wind-towers, badahanj, badhahanj, badhanj, badgir, baudgeer, malqaf, milqaf, mulquf, mashrabiyya, Alexandre Lézine, Franz Rosenthal, Olivier Jaubert, Lamees al-Dasouqi, Alev Masarwa, Hamdia Saleh Dilli, winds, astronomical risings / settings, archaeoastronomy, ethnoastronomy, Clive Ruggles, winter sunrise, Canopus, qibla, sacred direction, Ka'ba / Kaʿba, Mecca, Makka, Makkah, La Mecque, Joseph Chelhod, Simon O'Meara, street alignment, cardo, orthogonal street-plan, al-Tanukhi, al-Mas'udi, al-Muqaddasi, Ibn Fadlallah al-'Umari, Felix Fabri, Jean Coppin, al-Maqrizi, Ibn Taghribirdi, Ahmad Taymur, al-Ghuzuli, Ibn Abi Hajala, astronomy in Egypt, astronomy in medieval Egypt, Ibn Yunus, Caliph al-Hakim, Najm al-Din al-Misri, Ibn al-Qasih, Ibn al-Majdi, François Charette, Petra Schmidl, astronomy, astronomical tables, astronomical timekeeping, times of Muslim prayer, Islamic prayer-times, sacred geography, mosque orientations, mosque alignments, Michael Bonine, Mònica Rius, Abd al-Latif al-Baghdadi, Cairo Geniza, S. D. Goitein, Paulina Lewicka, 1001 Nights / Arabian Nights, Ibn al-Rami / Tunis, Prospero Alpino, Antonius Gonzales, Evliya Chelebi, Edward W. Lane, Napoleon in Egypt, Description de l'Égypte, Musafirkhane, Frederic Louis Norden, Girault de Prangey, Jean-Léon Gérôme, David Roberts, Friedrich Maximilian Hessemer, Gabriel Legekian, Beniamino Facchinelli, Jakob August Lorent, Wilhelm Hammerschmidt, Elfriede Knauer, Hassan Fathy, Ugo Monneret de Villard, Eustace Corbett, K. A. C. Creswell, Christel Kessler, Felicitas Jaritz, Jonathan Bloom, Eleonora Fernandes, Doris Behrens-Abouseif, Nicholas Warner, John Cooper, Peter Sheehan, Red Sea Canal, *amnis Traianus*, Fortress of Babylon, Iran, Yazd, Susan Roaf, Mehdi Bahadori, Pakistan, Hyderabad (Sindh), Dubai, Hormuz, Marco Polo, Masdar City, Edward Said, Robert Irwin, Fuat Sezgin, orientalism, orientalist

Subjects treated besides the 1,001-year history of the Cairo wind-catchers:

- orientalists and the documentation of the history of Islamic civilization (this section has been suppressed by the author to reduce the length of the monograph; occasional remaining references will make the author's point of view clear);
- 'orientalist' paintings can be accurate testimonials to the way the Orient used to be (that is, they are not all racist and sexist distortions of the Orient);
- a look at wind-catchers and passive cooling elsewhere in the Muslim world, from Sicily to Sindh;
- the forgotten half of the history of astronomy, that is, spherical astronomy, astronomical timekeeping and astronomical instrumentation;
- materials for the first history of astronomy in Islamic Egypt;
- the astronomical orientation of the Kaʿba in Mecca and what it tells us about the edifice;
- the way in which the orientation of the Kaʿba affected mosque orientations over the centuries with the use of astronomical risings and settings for the sacred direction (*qibla*);
- the newly-rediscovered tradition of sacred geography of Islam, which advocates the use of astronomical horizon phenomena for the *qibla* from al-Andalus to China;
- an explanation of the different ways Muslims have used to find the sacred direction (*qibla*) toward the Kaʿba: folk astronomy and mathematical geography;
- the reasons why historians of Islamic architecture invariably overlook or misunderstand the most important aspect of that architecture, namely, its orientation;
- new light on orientations and the urban development of medieval Cairo;
- new orientations for the history of Islamic architecture and urban planning with cities oriented toward the Kaʿba; and, last but not least,
- the demolition of recent fallacies about the orientation of historical mosques and about the origins of Islam (suppressed by author here because these demolitions are available in his 2018 publications).

“Il est bon de savoir quelque chose des mœurs de divers peuples, afin de juger des nôtres plus sainement, et que nous ne pensions pas que tout ce qui est contre nos modes soit ridicule et contre raison, ainsi qu’ont coutume de faire ceux qui n’ont rien vu.” / “It is a good thing to know something of the way of life of different peoples in order to judge our own more sensibly and not think, as do people who have seen nothing of the world, that everything that is different from our ways is ridiculous and irrational.” René Descartes (1596-1650), *Discourse on Reason* (1637).

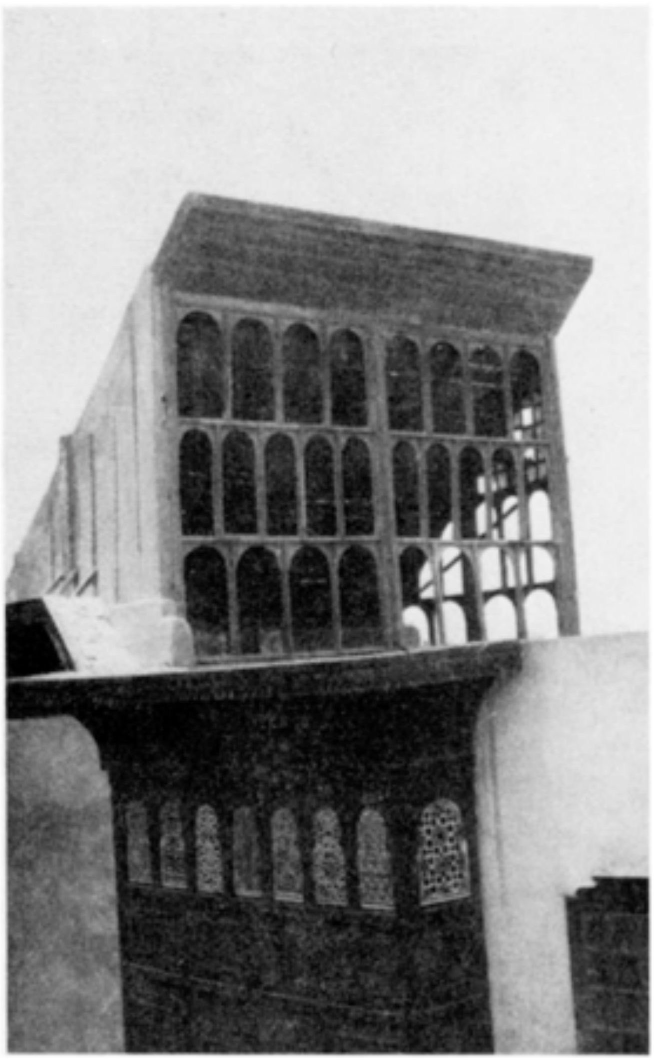
“But that’s the glory of foreign travel, as far as I am concerned. I don’t want to know what people are talking about. I can’t think of anything that excites a greater sense of childlike wonder than to be in a country where you are ignorant of almost everything. Suddenly you are five years old again. You can’t read anything, you have only the most rudimentary sense of how things work, you can’t even reliably cross a street without endangering your life. Your whole existence becomes a series of interesting guesses.” Bill Bryson, *Neither here nor there: Travels in Europe* (1992). [DAK: Note that Bill Bryson was not writing about Cairo, but he could have been.]



“**Why 2020 is the year to visit Cairo.** Founded in 969 AD, modern Cairo may seem young in comparison to the 4,500-year-old pyramids just across the Nile. But the city has seen its own share of history in its lifetime, including occupations by the Ottomans and British [DAK: maybe add the French?] and revolutions [DAK: against the French and then against the British] that changed the course of the country. ... ... **Why do people love it?** With more than 20 million people living in the metro area, Cairo has “an energetic pulse”, according to Lauren K. Clark, an American writer who has lived in Cairo since 2010. She attributes the city’s energy to the varied cultures, social classes and natural environment found here, explaining that each part of the city has its own vibe and culture where these facets shine. “You have the modern, upbeat, club side. You have the rural, green, lush pastures side. You have the side where you feel like you are in the ancient times,” she said. “And the fascinating thing is that Cairo has managed to sustain all these different entities. This is the magic and wonder of the city.” Lindsey Galloway, “Why 2020 is the year to visit Cairo”, *BBC World*, 13.01.2020.

“History is merely a list of surprises. It can only prepare us to be surprised yet again.” Kurt Vonnegut, *Slapstick, or Lonesome no more!* (1976).

“Everything is more complicated than it looks.” Murphy (eternal).



"I am a *bādahanj* all filled
With emotion, joy, and happiness,
High on top of me, the pigeons sing.
Inside me, the winds recite love poems."
The poet Burhān al-Dīn al-Qīrāṭī,
Cairo, 1350

"Larvatus prodeo." / "J'avance masqué." / "Masked I proceed."
Descartes, 1637.

Part I
The historical sources

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Summary

Suppose nobody knew about the Pyramids of Egypt; they had been long forgotten and some had collapsed and others had been demolished for their stones. Suppose further that some Egyptians and some foreign travellers in more recent times, but still centuries ago, had written about their impressions of the Pyramids, and some travellers had painted pictures of them, but these materials, hidden in libraries and museums, were barely known to anybody today. Imagine further that Egyptologists were interested only in temples and palaces and hieroglyphics, and that the Pyramids, known only to a few, were of no interest to them because these splendid monuments involved mathematical and astronomical notions and evidence of phenomenal engineering prowess, taboo subjects to most historians. No tourists to Egypt nowadays would ever be shown the Pyramids, even though they might have been the icon of Ancient Egypt. Also, it was not widely known that there were also Pyramids in the Sudan. Which came first? ("Egypt first!", "Sudan first!") Which were better? ("Be best!") Seldom were these questions posed, and then invariably by people who knew only one group or neither. The international historians of vernacular pyramids and the experts on constructing environmentally-friendly pyramids know nothing of the pyramids of Egypt, being too concerned with pyramids elsewhere.

Now this silliness should stop right here.

But wait! In medieval Cairo there was also an icon of the city which has suffered a similar fate to those imaginary pyramids. Medieval people knew about them because they featured on most buildings in the city. Early modern people did away with most of them when the city was modernized because the modernizers, who were foreigners and who were in control, thought they (not themselves) were dispensable. People these days do not know about them. No tourists are ever shown the few that remain; they never got to have a 'like'. Where did these things come from? Ancient Egypt? (Sounds reasonable.) Maybe Iran? (They had a Persian name.) Some nut has even claimed they had an astronomical connection. Also, the international community of scholars who write on wind-towers and

wind-catchers knows virtually nothing of the wind-catchers that featured in Cairo for over a thousand years, and the international community of environmental engineers, who in droves write about wind-catchers, is not generally aware of the Cairene examples. So maybe it's time for a closer look.

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The purpose of this study is to draw attention to a remarkable and very distinctive feature of the architecture of medieval Cairo, namely, the wind-catchers which in their hundreds and probably even thousands graced the roofs of houses and palaces as well as religious architecture. It is not this author who claims that these devices were very widespread in medieval Cairo. Two medieval authors state this specifically and dozens hint at it; furthermore, two substantial medieval anthologies of poetry laud the wind-catchers and not a few astronomical texts confirm the way in which they should be set up.

These wind-catchers were well suited to the climatic situation of Cairo because the favourable winds from the north could be captured in a wind-scoop on the roof and forced down a ventilation shaft into the living quarters below. They were not usually permanent constructions and, being often made principally of wood, they had to be repaired or renewed or replaced by succeeding generations. In any case, the vast majority had disappeared already by the 19th century. On the other hand, the earliest surviving Cairo wind-catcher, from 1350, was made of stone, which is one reason why it survived.

Fifty years ago one could count the surviving examples on the fingers of two hands. Twenty years ago a spectacular example, built according to precise medieval prescriptions, burned to the ground, and nobody gave a damn. News reports bemoaned the loss of the palace, but its monumental wind-catcher was not mentioned. Nevertheless, the wind-catchers of Cairo deserve not to be forgotten, for they were very much part of the Cairo scene from the 10th to the 19th century. Maybe they even have a message for us in the 21st century.

The wind-catchers of medieval Cairo are an important, but much neglected, part of the history of Islamic architecture in Cairo. They also had an astronomical connection and this leads us into the history of astronomy in medieval Egypt. Outside of Greater Iran, where wind-towers are well-known, they obviously they constitute a very significant chapter in intelligent environmental control.

At the outset I stress that my present interest is in the wind-catchers of medieval Cairo, for which we have sources from the 10th century onwards. It is necessary, however, to make a preliminary survey of the available sources for the wind-catchers of medieval Iraq and Syria, which merit a more detailed study by a younger researcher. I offer no excuses for presenting only a brief summary of the history of the spectacular wind-towers of Iran since they are to some extent documented and researched. The trans-regional transmission of the notions underlying the uni-directional wind-catcher is a subject for a future researcher, and the evidence is linguistic as well as literary and archaeological. In other words, this is hardly a subject for an engineer or a green architect.

There are some 30-odd references to wind-catchers in historical literature of one kind or another and dozens of references in medieval Arabic poetry, in addition to some 150-odd images in paintings from 1750 onwards and photos from 1850 onwards. The texts provoke images of a variety of situations, from the workman collecting his wages for cutting wood to make a hood for a wind-catcher to the drunken judge who spent the night hidden in the ventilation-shaft below a wind-catcher, out of sight of a caliph busy in his harem. The images show that the wind-catchers could have openings of a modest 1.5 m square or a gigantic 30 m wide, and that they could be made of wood and last 25 years or be made of stone and last 500 years.

We shall concentrate here as much as possible on the wind-catchers themselves and not so much on those visitors to Cairo who described them, the poets who were fascinated by them, the astronomers who wanted them to be oriented in a certain direction, the painters and the photographers who captured them, and the modern scholars who have mentioned them. The biographical details I give for these folk may be out-of-date. For

matters relating to Islamic civilization I rely considerably on the authoritative articles in the *Encyclopaedia of Islam* (2nd edn.), and I make no apology for this, even in cases where I suspect there may be more reliable and more recent sources available. At my advanced age, I don't mind being considered old-fashioned or out-of-date myself. Readers may know of a better source, or may prefer to wait for the appropriate article to appear in the newest edition of the *Encyclopaedia of Islam*, or they can always at their own risk check the articles (of widely varying quality) on Wikipedia.

By 'Cairo' I mean 'Cairo-Fustat'. Fustat was the first Muslim settlement in Egypt in 643 and remained of prime importance as a thriving city, one of the wealthiest in the Muslim world, long after the new city of Cairo had been built in the year 969. Cairo was the city of the caliphs and military aristocracy. Fustat was the city where people lived. But it suffered various catastrophes, including famine and epidemics, evacuation before the Crusaders, and deliberate burning in 1168/69. Today Fustat is an enormous archaeological site. Meanwhile Cairo expanded in the Mamluk period into various suburbs around the Fatimid city. This monograph barely concerns modern Cairo.

The basic documentation of historical architecture in Cairo has been conducted by a series of scholars of different nationalities. In the 19th century it was considered adequate to publish a book with a few pictures. In the 20th century there appeared first the French school based at the Institut Français d'Archéologie orientale in Cairo, then the British school based at the American University in Cairo, then the German school based at the Deutsches Archäologisches Institut. To name just three representatives of these traditions we choose Bernard Maury, Archie Creswell, and Michael Meinecke, and thereafter, Doris Behrens-Abouseif, based the School of Oriental and African Studies in London, and Nicholas Warner, at the time based at the American Research Center in Egypt. Each of these Cairo-based institutions and individual scholars was concerned with the preparation of plans, photographic records, and detailed descriptions. The Egyptian scene could not always be considered on its own; some of these scholars were also studying historical architecture in

any of Jerusalem, Damascus and Aleppo. Every time one of these scholars encountered a wind-catcher, be it a real one with a catcher on the roof, or a decapitated air-shaft, or a grille at the bottom of such an air-shaft, he/she would document it. These scholars who did the basic work were followed by several generations of architecture historians who would study this edifice or that, or this feature or that, in order to complement the work of the predecessors, with the result that some would publish new surveys of historical Egyptian architecture with no text, or no pictures, or even no new information of any kind.

Our wind-catchers have not been given sufficient attention by the specialists in the history of Islamic architecture with their penchant for monumental architecture; they are not known to appreciate what they like to call vernacular architecture. However, the wind-catchers featured also on the monumental and religious architecture of medieval Cairo. This omission would not in itself be serious (who cares?), but as a result the Cairo wind-catchers have also been mainly overlooked in the important new genre of studies dealing with clean/green energy.

Nowadays environmentalist engineers frequently mention the wind-catchers in medieval Cairo but always briefly in a sentence or two, because they know of no serious documentation of these devices. They much prefer the wind-towers of the Iranian city of Yazd and other locations from Arabia to Sindh, which are far better known and also better preserved, being made of more solid stuff. Yet the wind-towers of Yazd are much more recent than the wind-catchers of Cairo, which is another reason they are still *in situ*.

Now fortunately the Cairo wind-catchers are mentioned in medieval Egyptian *belles-lettres* and poetry, documents relating to religious endowments of buildings, and, last but not least, astronomical texts. Also, they feature prominently in various travel accounts from the period 1200-1900, as well in numerous orientalist paintings from the 19th century and early photographs and post-cards mainly from the late 19th and early 20th century.

Four rather basic studies from the period 1970-2000 are devoted specifically to the Cairo wind-catchers:

(1) Alexandre Lézine in his exploratory article “La protection contre la chaleur dans l’architecture musulmane d’Égypte” (1971) can be credited with bringing the existence of the Cairo wind-catchers to the attention of the scholarly world.

(2) Franz Rosenthal in “Poetry and architecture: The *bādhanj*” (1977) deals with the Cairo wind-catchers in medieval Egyptian *belles-lettres* and poetry. The sources date from the 11th to the 14th century. This study emphasises the abundance of these architectural features in the medieval city, and underlines the affection in which they were held in the popular mind.

(3) David A. King in “Architecture and astronomy: The ventilators of medieval Cairo and their secrets” (1984/2004) deals with the orientation of the wind-catchers as revealed by a remarkable astronomical table first discovered in 1970. The orientation of the wind-catchers is further documented in various medieval Egyptian astronomical texts dating from the 10th to the 18th century. We learn from these texts, for example, that the wind-catchers were aligned so that they faced the direction perpendicular to winter sunrise. What (on earth) does that mean?

(4) Olivier Jaubert in “Capteurs de vents d’Égypte – Essai de typologie” (1995) documents in as much detail as possible some 50 medieval Cairene wind-catchers, of which a few that can be counted on one hand survive intact and the rest are known by surviving air-shafts depicted on architectural plans or illustrated in the various engravings and paintings. His work also deals with some 20 similar devices from Ancient Egypt, Coptic Egypt and modern Egypt. Jaubert organized the buildings chronologically and classified the different types of wind-catchers represented in his survey.

Only the third and fourth of these studies includes a photo of a surviving Cairene wind-catcher. In fact, until recently, no other scholarly study known to this author from the past 100 years includes more than one or

two photos or images of a Cairo wind-catcher. A popular book on Cairo by Oleg Volkoff does present several photos not available elsewhere.

These four studies have invariably been overlooked in writings by both historians of Islamic architecture and environmentalist engineers. Lézine 1971 is the only one that has been cited by a few authors. Rosenthal 1977 has been cited by several serious orientalists, as well as by a couple of Iranian engineers who love poetry as much as wind-towers. King 1984 has been overlooked by all and sunder. Jaubert 1995 has only been seriously used in a Cairo dissertation.

A brand new study remains unavailable at the time of writing. The Egyptian student, Lamees al-Dasouqi, submitted in 2014 to Ayn Shams University in Cairo a Master's thesis on wind-catchers in Mamluk and Ottoman Cairo, using the copious data presented by Olivier Jaubert. That data source she classified as "incomplete". This new work is known to the present author only by its title and a summary on the internet, but it apparently contains several dozen images. Various attempts to reach Ms. al-Dasouqi and the two professors who oversaw her thesis were to no avail.

A very important new study came to my attention as this monograph was nearing completion. Alev Masarwa of the University of Münster has published in 2017 a selection of poems on the *bādahanj* from a newly-discovered Mamluk anthology different from the one used in Rosenthal 1977. Her work raises the study of the literary sources on the *bādahanj* to a new level.

One aim of the present monograph is to encourage young researchers to read these earlier studies and learn:

First, how the wind-catchers that were omnipresent in medieval Cairo were erected and how they functioned in order to receive the favourable winds and block out the unfavourable ones, which we learn from astronomical texts, and how they were appreciated for their elegance and erotic overtones by medieval *littérateurs* and poets;

Second, how scholars have valiantly sought to document all surviving examples, and all examples of which there is still just a trace to be found, either archaeological or textual;

Third, how orientalists, who, as we shall see, are not all bad, conduct (or at least used to conduct) their research;

Fourth, how some modern sources tend to latch onto errors that scholars have made in the past and ignore the rest of what they wrote, so that, in some case, the errors themselves become history.

Fifth, how young researchers can penetrate a singularly inter-disciplinary subject about which their teachers have somehow remained uninformed; and

Sixth, how not to conduct research, that is, to publish without using any original sources, or by mis-citing secondary literature, or, still worse, by fabricating citations.

There are numerous problems concerning the wind-catchers that have not been solved. The most striking one is**: if the Cairo wind-catchers represent a continuous tradition from Ancient Egypt through Coptic Egypt to the new city of Fatimid Cairo, founded in 969, why do they have, from the 10th century onwards, an Arabicized Persian name باذاهنج, *bādhāhanj* and variants thereof? And why is one of the four varieties mentioned in the astronomical sources called فراتي, *furātī*, clearly relating it to the Euphrates (الفرات, *al-Furāt*) and Iraq?** The sources that have been exploited thus far – historical, literary, astronomical, archaeological – do not cast any light on these problems. There are surely more sources available which have not been exploited yet, probably in the form of historical texts, legal documents and encyclopaedias. The history of Egypt is full of surprises. The 14th-century Maghribī philosopher, historian and sociologist Ibn Khaldūn described Cairo under the Mamluks as "a city beyond imagination". This we do not contest, except to include Cairo under the Fatimids, the Ayyubids, and the Ottomans.

Now there is another reason why the wind-catchers of medieval Cairo are important.[1] It is well known that Islamic religious architecture is supposed to be oriented in the *qibla*, that is, the local direction of the sacred Kaʿba in Mecca. Much has been written by historians of Islamic architecture and historians of urban development on the religious and domestic architecture of medieval Cairo. However, very little of this discussion is devoted to the orientation of this architecture, which is, of course, of prime importance to an understanding of the buildings themselves and also the underlying city-plan. The modern literature on Islamic architecture is full of non-committal references to *qibla*-walls and *qibla*-*īwān*s, without reference to the different *qibla*s that were adopted by various interest groups in medieval Cairo. The *qibla* in Cairo is related to its urban development in ways that are also inevitably always overlooked.

Medieval texts on the wind-catchers reveal that these devices were astronomically aligned, open towards the direction perpendicular to winter sunrise. But they were also aligned with the orthogonal street pattern of Fatimid and Mamluk Cairo. What does this tell us about the wind-

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[1] The word "medieval" is applied to historical Islamic civilization to designate the time when Islamic civilization in general and science in particular were flourishing and European civilization was stagnant and then started to bud. As far as the Muslim world is concerned, the term is not intended to designate anything backward. I classify the period of the *bādhahanj*es – 10th to 19th century – as 'medieval', as in العصور الوسطى, *al-ʿuṣūr al-wusṭà*, "the Middle Ages", because these devices are post-classical and pre-modern. The corresponding period of relevance for traditional Islamic astronomy is from the 7th to the 19th century.

Arabs and Muslims in general tend to look back at the "Golden Age" of Islam and recognize more easily than Westerners that a renaissance – النهضة, *al-nahḍa* – took place in Baghdad in the 8th-10th centuries. I too recognize that Islamic Renaissance. In the year 2001, on the occasion of the illegal and ill-fated invasion of Iraq, in which, to my shame, my own country participated, I gave a lecture in Frankfurt entitled "The renaissance of astronomy in Baghdad in the 9th and 10th centuries": see www.academia.edu/34703709/.

catchers? What does this tell us about the medieval street-plan? And what does it tell us about the mosques aligned with the street-plan? It's all about medieval understandings of the *qibla*. And we have informative medieval texts on the different *qibla*s that were used in Cairo mosques. There were two main *qibla* directions favoured in medieval Cairo, reflecting folk astronomy and mathematical astronomy: the first was winter sunrise at 27° S of E, and the second was calculated (already in the 10th century) as 37° S of E. But there were also other directions favoured by different interest groups.

In brief, **Cairo is just one example of a Muslim city aligned toward the Kaʿba in Mecca, which does not mean that the whole city faces the same direction toward the Kaʿba. There are, of course, many other Islamic cities that are oriented toward the Kaʿba.** Nevertheless, Cairo is one of the most interesting from the point of view of orientations. But how was this achieved? And why does nobody talk about it today? It is almost as if there were a conspiracy of silence about such matters.

The key to understanding the layout of the city was provided **some 50 years ago** by the discovery of a remarkable late-10th-century astronomical table for orienting the wind-catchers of Cairo. And some **20 years ago** the only surviving example of the kind of monumental wind-catchers that were common in medieval Cairo – the spectacular one serving the charming Musāfirkhāne Palace – was burned to the ground. Some **10 years ago** an extensive *Encyclopedia of Islamic Art & Architecture* was published by Oxford University Press: the article "Wind catchers" contains not even a mention of the wind-catchers that were omnipresent in medieval Cairo, and there is no article "Qibla" at all. It is perhaps time for some action.

This is not the final word on the wind-catchers of Cairo. I have been overwhelmed by the volume of literature available on the history of Cairo, its urban history, its architecture, its cultural heritage, its personalities, not excluding the Fortress of Babylon, Old Cairo and the Red Sea Canal. These writings could have forced me far away from the main topics on this study, on which, fortunately, little has been written, and virtually nobody seems to know about it.

A note on transliteration of Arabic and on Islamic dates

> “There are some ‘scientific systems’ of transliteration, helpful to people who know enough Arabic not to need helping, but a washout for the world. I spell my names anyhow, to show what rot the systems are.” T. E. Lawrence, in response to his publisher’s queries about different spellings of one and the same place-name in his manuscript. From *Seven Pillars of Wisdom*, Ware 1997 edn., p. xxvii.

Some effort has been taken to employ a user-friendly but consistent transliteration for Arabic words and names. The system used here is that of the *Encyclopaedia of Islam*, with minor simplifications (*j* for *jīm*, *q* for *qāf* and no underlining of double letters to represent a single Arabic letter such as *sh* for *shīn*). The following table shows the letters of the Arabic alphabet together with their initial/medial/final forms (from right to left, more or less), their names in transcription, and the equivalents that we use:

Transliteration of Arabic

ا	-	*alif*	*a*	س	سسس	*sīn*	*s*	ك	ككك	*kāf*	*k*
ب	ببب	*bā’*	*b*	ش	ششش	*shīn*	*sh*	ل	للل	*lām*	*l*
ت	تتت	*tā’*	*t*	ص	صصص	*ṣād*	*ṣ*	م	ممم	*mīm*	*m*
ث	ثثث	*thā’*	*th*	ض	ضضض	*ḍād*	*ḍ*	ن	ننن	*nūn*	*n*
ج	ججج	*jīm*	*j*	ط	ططط	*ṭā’*	*ṭ*	ه	ههه	*hā’*	*h*
ح	ححح	*ḥā’*	*ḥ*	ظ	ظظظ	*ẓā’*	*ẓ*	و	ووو	*wāw*	*w/ū/aw*
خ	خخخ	*khā’*	*kh*	ع	ععع	*‘ayn*	*‘*	ي	ييي	*yā’*	*y/ī/ay*
د	ددد	*dāl*	*d*	غ	غغغ	*ghayn*	*gh*	‘	-	*hamza*	*‘*
ذ	ذذذ	*dhāl*	*dh*	ف	ففف	*fā’*	*f*				
ر	ررر	*rā’*	*r*	ق	ققق	*qāf*	*q*				
ز	ززز	*zāy*	*z*								

Sometimes, two letters will be underlined in order to indicate that they correspond to a single Arabic letter. Numerous times we shall encounter the medieval Classical Egyptian Arabic word for wind-catcher, namely, باذاهنج, *bādhāhanj*, which would be pronounced *bādahang* in colloquial Egyptian. The term in use for wind-catcher since the 19th century is ملقف, *malqaf,* which is pronounced *mal'af* in modern colloquial Egyptian.

In this system, letters like *ǧ* and *š* have deliberately been avoided. The German orientalist rendering *bādahanǧ* for our wind-catchers will not work on the internet. The worst ever in that tradition is perhaps al-Ḥadschdschādsch for al-Ḥajjāj, which is even attested in a book-title.

For those who do not know Arabic, to pronounce these words in transliteration one can ignore the dots but one should take heed of the consonants bearing them. I note that TV announcers these days like to say '*Tareer*' for *Taḥrīr* and '*Mamoud*' for *Maḥmūd*. But one should take heed of the long vowels *ā*, *ī* and *ū* and get them right.

I note that TV announcers persist in saying *al-qaʿīda* for *al-qāʿida*, which words mean two different things in Arabic. The former means "woman companion"; the latter means "base". Or they create long vowels where there are none in Arabic, as in "Katār" for Qaṭar. As a rule, Western news announcers have a tendency to rearrange the vowels in Near Eastern names: Hashīm for Hāshim, Kabūl or Kābūl for Kābul. Specific European influence, in this case French, is evident in such renderings as Hassan and Al-Assad (from Ḥasan and al-Asad). Many Arabic names and words find themselves subtly modified when rendered in other languages, such as is the case with Cairo, Luxor, Said, and Etihad (from al-Qāhira, al-Aqṣur, Saʿīd or Ṣāʿid, and *ittiḥād*), to mention just a few. The name Muḥammad, with three vowels and a special 'h' and a doubled 'm' has been subjected to all sorts of renderings in other languages; in Turkish it becomes Mehmet, in Uighur Muhemmet مۇھەممەت, and in Italian Maometto.

Inconsistencies abound in Western renderings of Arabic names and Egyptian words and place-names, especially when the names are not Arabic anyway. Just google the name of the region of Cairo which used to flood every year, namely, "Ezbekieh" and you come to a Wikipedia entry

for “Azbakeya”, which tells you that the name is “Uzbakeya also spelled “Al Uzbakeya” or “Auzbekiya” and then continues with “Azbakeya”. The area was saved from the waters under the Mamluk prince Uzbek (as in Uzbekistan) in 1486. Doris Behrens-Abouseif, author of a book on the early history of this important suburb, has “Azbakiyya”, which is correct for the Arabic name. The most common modern rendering appears to be “Ezbekieh”, but there is no final ‘h’ in the Arabic name, and the introduction these days of the final ‘h’ all over the place, as in the new forms “Makkah” and “Madinah”, is not to be encouraged (not least because there is no final ‘h’ in the Arabic). In the French of *ca*. 1840 (translation of al-Jabartī’s account of the French occupation) the suburb is very appropriately called “Ezbèkié”, which any Cairene would understand if they heard it pronounced properly. Later French insists on suppressing the ‘z’, thus “Esbekiye”. Classical Arabic would be “Uzbakiyya”, but this would make most Cairenes laugh. In fact, the Turkish name of the Mamluk prince was “Özbeg” (with variants “Üzbak” and “Üzbīk”), as testified by the article in the *Encyclopedia of Islam*.

Another nice example is *mashrabiyya*, a feminine word used for the intricate wooden window-grilles which, even though their original purpose was somewhat sinister, were often veritable works of art. This term has become, at least in French, *moucharabieh*, and what is perhaps worse, it is now masculine, as in *le moucharabieh*. One of my favourite dishes is rabbit with **ملوخية** , *mulukhiyya*, that is, “mallow”, which MiddleEastKitchen.com explains can also be spelled “*molokhia*, *mulukhiyah*, *mloukhiya*, *molohiya*, *malukhiyah*, or *moroheiya*”, typical of the fate of transliteration of Arabic words that were originally borrowed from other languages. According to wikipedia.org/wiki/Mulukhiyah, the plant was called μαλάχη (*malákhē*) or μολόχη (*molókhē*) in Ancient Greek.

I make no apologies for the occasional renderings of names and words in Judaeo-Arabic, Hebrew, Persian and Turkish. Likewise, the Arabic text has a tendency to rearrange itself when mixed with English text on the same line; معليش , it’s the best that I can do.

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Year-numbers in the Hijra calendar (H) are marked as such. Western equivalents (W), often spanning two consecutive years, can be found approximately using the formula W = 622 + H/33. Exact equivalents can be found on www.muslimphilosophy.com/ip/hijri.htm.

Part Ia
The wind-catchers of medieval Cairo

1 — Introduction

The rationale behind this study and its timing

"The cradle of western civilization rocked in the eastern basin of the Mediterranean." The Hungarian Jewish Orientalist Ignaz Goldziher (1850-1921), from the very useful English translation of his Hungarian high-school textbook offering a *History of Classical Arabic Literature* (1908/1966), p. 1.

"If ... local methods do not provide all that is needed in an age of change and activity, they are at any rate, though perhaps curiously, adapted to the physical conditions of the country; and an architect will lose nothing by studying them respectfully." Ernest Tatham Richmond (1874-1955), sometime Director of Public Buildings for Egypt, addressing the Royal Institute of British Architects in 1911 on the subject of indigenous Egyptian building techniques, quoted in Guy T. Petherbridge, "(Islamic) vernacular architecture – The house and society" (1978), p. 193.

"From a cultural perspective, the production of commodities [DAK: such as wind-catchers and/or air-conditioners] is also a cultural and cognitive process: commodities must be not only produced materially as things, but also culturally marked as being a certain kind of thing. Out of the total range of things available in a society, only some of them are considered appropriate for marking as commodities. Moreover, the same thing may be treated as a commodity at one time and not at another. And finally, the same thing may, at the same time, be seen as a commodity by one person and as something else by another. Such shifts and differences in whether and when a thing is a commodity reveal a moral economy that stands behind the objective economy of visible transactions." Ivor Kopytoff, "The cultural biography of things: commoditization as process" (1988), quoted from the summary.

"Before air conditioning became ubiquitous, Emiratis were more than capable of staying cool, employing vernacular architecture

> which sheltered people from the harsh climate without the need for electricity. These traditional building techniques were sidelined as the city moved towards a contemporary vision wrought of concrete, steel and glass. But as Dubai prepares for Expo 2020, national pavilion announcements show a revival of low-tech sustainability is underway." Tom Page, "Expo 2020 Dubai plans to bring sustainable architecture home", cnn.com, 7th March 2019.

> "We looked for instruments of mass calculation in Iraq and surrounding regions and we found a mountain of evidence proving that the astronomical instrumentation that concerns us here started right there in Iraq in the 8th and 9th centuries. From there, it spread to all corners of the Islamic world where serious astronomy was practiced. We can document a thousand years of Muslim activity in this field, none of which ever did anybody any harm." D. A. King, *Instruments of Mass Calculation*, vol. 2 (2005) of *In Synchrony with the Heavens*, p. ix.

The wind-catchers of medieval Cairo belong to a category of things that is sometimes referred to as "unknown unknowns that nobody knows about".[2] I was reminded of this expression in January, 2020, as we risked yet another escalation of violence in the Near East, which would have focussed on Iran. The wind-catchers, like wind-mills, are nothing more or less than symbols of peace, but they are also symbols of common sense. Almost 20 years ago, when various Western powers successfully sought to destroy Iraq, I was publishing a book about real "instruments of mass calculation", a story about astronomical instruments that started in Iraq in the 9th century and went off with a bang that was still being felt in the European Renaissance. Unlike others, I did have evidence for my claims. This time, quite by chance, I am writing about something very sensible that started in Iran long before that. It also started independently in Ancient Egypt. Now, unlike certain others, I again have evidence that the Iranians

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2 https://en.wikipedia.org/wiki/There_are_known_knowns.

of yore did something so brilliant that it was adopted in medieval times by the Iraqis and by the Egyptians and even in modern times by American university students in Colorado.

The wind-catchers of medieval Egypt are “known” in the sense that you can google “wind-catchers Egypt” and get something, but it is only a couple of sentences which neither illuminate nor blow your mind. If you are lucky you may get a picture or two. There are one or two of these devices left in Cairo but 99% of tourists will never see them, even if they do visit the pretty palaces on whose roofs wind-catchers are still to be found. The Cairo wind-catchers are rarely mentioned in the scholarly literature, but that hardly counts anyway. If you google “malqaf”, the modern Arabic word for wind-catchers, you will get all sorts of information except the historical.

One could argue that the Cairo wind-catchers are “known unknowns” in the sense that numerous people have referred to them without knowing anything of consequence about them. This is true of much popular writing on historical topics. Or one could claim they are “unknown knowns” in the sense that certain scholars have studied their profusion through medieval Egyptian literature and even documented the surviving examples, but their writings have in the main been overlooked. The scholars who should know about their existence over a millennium, namely, environmental engineers and architects, certainly do not know much about them. So I shall stick to the (silly) expression “unknown unknowns—the ones we don’t know we don’t know”. And unlike the unknowns of the proponents of the lies about Iraqi weapons of mass destruction, the Egyptian devices of mass ventilation did exist. In any case, as far as the wind-catchers of medieval Cairo are concerned, it’s time for a closer look.

The leading historian of Islamic astronomy of the 20th century, Edward S. Kennedy, further said the following about the thousands of medieval Islamic astronomical tables which exist in manuscript libraries around the world: “they never did anybody any harm.” I have written the same about the hundreds of medieval Islamic astronomical instruments which survive in museums around the world. In this monograph I shall try to show that

the wind-catchers of medieval Cairo never did anybody any harm either. Except perhaps the Frenchman mentioned by Jean Coppin *ca*. 1645 who was out on a dubious night-time rooftop escapade and fell down a ventilation shaft. More anon.

Nevertheless, no feature of historical Islamic architecture has been more neglected in the mainstream literature than the wind-catchers of medieval Cairo. They have also been almost totally overlooked by those who have written on environmentally-friendly features of historical architecture around the world.

The medieval and early modern textual sources discussed in **Part I** inform us that the majority of houses in the city from the late 10th century through to the 16th, 17th and 18th centuries were fitted with wind-catchers on their roofs to force the cool northerly winds down air-shafts in order to freshen the living quarters below. The four principal studies of these devices and the relevant medieval texts – Lézine 1971, an introductory study and overview; Rosenthal 1977 on the wind-catchers in medieval Egyptian poetry; King 1984 on medieval Egyptian astronomical texts which mention their construction and orientation; and Jaubert 1995 documenting all known examples, although far more have disappeared without trace – have somehow been overlooked by the vast majority of scholars who have written on medieval Cairene architecture on the one hand and on historical renewable-energy devices in the Islamic world on the other.

Traditional wind-towers and wind-catchers are known from the Gulf to Pakistan, those in Iran being particularly well documented and those in the Emirates being shown to every tourist. They are also attested in Ancient Egypt, although this is debated, yet new evidence is available. If so, then why were the omnipresent Cairo wind-catchers from the 10th to the 19th century known by an Arabicized Persian name, باذاهنج, *bād<u>h</u>āhanj*, written in several different ways. How did this come about? (The modern Arabic name ملقف, *malqaf*, was not used in medieval times to refer to a *bād<u>h</u>āhanj* or *bādahanj*; it appears for the first time in the 19th century.)

The abundance of the wind-catchers in Cairo is still discernible in the images presented in **Part II**, which date mainly from the 19th and early

20th century, but they are hardly representative of the medieval tradition. Particularly the illustrations in the volume on “*L’Égypte moderne*” in the sumptuous multi-volume *Description de l’Égypte* prepared by the scholars of Napoleon *ca*. 1800 remind us of what Cairo at all levels of society looked like in previous centuries. Whereas these images show occasional wind-catchers here and there, sometimes in abundance, and occasionally of enormous dimensions, we know from the earlier medieval written sources that wind-catchers of all shapes and sizes were to be found on most buildings, domestic and religious, centuries earlier.

The four studies devoted to the wind-catchers of medieval Cairo are the following:

(1) Alexandre Lézine in “La protection contre la chaleur dans l’architecture musulmane d’Égypte” (1971) points to the existence of the wind-catchers and mentions a few attestations of them in the medieval Islamic literature and the medieval and early modern European travel literature. His study points to obvious points of departure for future scholars, and it was known to Rosenthal, King and Jaubert.

(2) Franz Rosenthal in “Poetry and architecture: The *bādhanj*” (1977) deals with the Cairo wind-catchers in a medieval Egyptian anthology of poetry by al-Ghuzūlī. The sources date from the 11th to the 14th century, and bear witness to the abundance of these architectural features in the medieval city, and Rosenthal’s masterful analysis of them underlines the affection in which they were held in the popular mind.

(3) David A. King in “Architecture and astronomy: The ventilators of medieval Cairo and their secrets” (1984/2004) deals with the orientation of the wind-catchers as revealed in a – at first sight – very curious astronomical table first discovered in 1970 and discussed in “Ibn Yūnus’ *Very Useful Tables* for timekeeping by the sun” (1973). The orientation of the wind-catchers is further documented in various medieval Egyptian astronomical texts dating from the 10th to the 18th century. We learn from this table and from these texts that the wind-catchers were aligned so that they were open toward the direction perpendicular to winter sunrise. What (on earth) does that mean?

(4) Olivier Jaubert in “Capteurs de vents d’Égypte – Essai de typologie” (1995) documents in considerable detail some 50 medieval and early-modern Cairene wind-catchers, of which a few that can be counted on one hand survive today and the rest are known by surviving air-shafts depicted on architectural plans or illustrated in the various engravings and paintings. His work also deals with some 20 similar devices from Ancient Egypt, Coptic Egypt and modern Egypt. Jaubert organized the buildings chronologically with complete bibliographical references and he further classified the different types of wind-catchers represented in his survey.

None of these four studies has been seriously cited by anyone who has written on medieval Cairene architecture since, at least not until just a few years ago!

From the publication of the *Description de l’Égypte* and until 2010 no book or article known to this author has mentioned the Cairo wind-catchers in more than a sentence or two or has contained more than one or two of the more than over 200 images of Cairene wind-catchers presented in **Part II**. However, during the course of the present monograph in 2019, I became aware of four new studies.

(5) A detailed investigation published in 2010 by the papyrologist Robert W. Daniel of the University of Cologne, of the orientation of domestic architecture in Greco-Roman Egypt. Taking due consideration of ventilation devices in this architecture Daniel takes the trouble – more than any other Western scholar – to point informatively to the tradition of wind-catchers in medieval Cairo. He is aware of Rosenthal 1977 and King 1973/1984, and presents illustrations of seven substantial Cairene wind-catchers.

(6) In 2014 Lamees al-Dasouqi of Ain Shams University in Cairo (Heliopolis) submitted a Master’s thesis in Arabic on Mamluk and Ottoman-era wind-catchers. The author was able to use the substantial data in Jaubert 1995. Her thesis apparently contains dozens of illustrations, but alas, it is not yet available for inspection. She appears not to have been aware of Rosenthal 1977 and King 1984.

(7) In 2017 Hamdia Saleh Dilli of al-Qadisiya University in Iraq published a paper in Arabic entitled “Cooling devices in the Abbasid Age”. The author surveys a dozen medieval literary sources on wind-catchers and wind-towers, but her interest is not specifically in the Cairo scene. She was apparently not aware of any serious Western sources.

(8) In 2016 Alev Masarwa of the University of Münster presented a paper “Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space” in a panel appropriately called “Reinterpreting cities” at the 13th International Conference on Urban History in Helsinki. Masarwa discusses two medieval Egyptian Arabic anthologies of poetry by the 14th-century scholars al-Ghuzūlī and Ibn Abī Ḥajala, after she had investigated the previously-unstudied poems on wind-catchers in the latter anthology. Rosenthal 1977 had dealt with the poems of al-Ghuzūlī. Masarwa’s study dealing with the anthology by his contemporary Ibn Abī Ḥajala was published in 2017 in a volume of studies on the literary works of that remarkable scholar. It is a very valuable supplement to Rosenthal’s early study, and is in the same orientalist tradition, with, alas for the uninformed reader, not a single illustration. The author had consulted King 1984 but was not aware of Jaubert 1995. More anon.

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Many of the later devices, especially the monumental wind-catcher of the Musāfirkhāne Palace, remain true to the medieval tradition of aligning them according to medieval Egyptian folklore of the winds and according the street-plan of the Fatimid city, with a special, ingenious feature to enable them to receive all of the favourable winds and block all of the unfavourable ones. We are happily in a position to offer **more than one *quid pro quo*** – very important these days. If you accept from **Part 1a** that the wind-catchers were a significant part of medieval Cairene architecture, you will be introduced in **Part 1b** to the history of astronomy in medieval Egypt, another subject that has received poor publicity. You will further learn that the wind-catchers teach us something about the layout of medieval Cairo that is not generally known. It is time, perhaps, to “find something new”.

The discovery of the orientation of the Cairene wind-catchers around 1970 also enabled new insights as to the way the layout of the medieval city accords with the various directions accepted by different interest groups for the sacred direction or *qibla* toward the sacred Kaʿba in Mecca. Historians have asked whether this or that building is "Mecca-oriented" or not, or have dared to say such silly things as "this historical mosque is not properly aligned toward Mecca", when they discover that the mosque does not face toward the modern direction of Mecca. In fact, all of the religious architecture in the city is oriented in the *qibla*; one just has to understand which *qibla* they were using. Whatever their orientation these mosques faced the Kaʿba, as in the Qur'ānic injunction, rather than the city of Mecca; there is a subtle distinction between these two situations. How this was achieved is outlined in medieval Islamic texts on sacred geography. It was mainly the scholars of the sacred law who proposed the notion of the world divided around the Kaʿba, with each sector associated with a segment of the perimeter of the rectangular base of the astronomically-aligned Kaʿba. The astronomers, on the other hand, calculated the *qibla* using the longitudes and latitudes of Cairo and Mecca (necessarily not the same as the modern coordinates) and applying mathematical procedures. Mosques in Cairo, as elsewhere, invariably reflect both the folk astronomical and the mathematical traditions.

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The present monograph is admittedly a rather unusual work of historical investigation. It is partly a survey of four articles dealing with a certain phenomenon that is attested in written works from the 10th century onwards, together with some 200 images, never before put together, which document the end of that phenomenon in the pictorial evidence from the 19th and early 20th centuries. Since from the outset, no publication in book form was planned, and given my advanced age and physical and technical limitations, I decided to publish this work on my own academic site on the internet. This is not a research paper of the standard academic kind; I did my research several decades ago and published it. The images, however, are new in the sense that no two of them have been published together to show what the wind-catchers looked like. Given the novelty of

most of the illustrations, and, not least, their presentation all together for the first time, as well as because of the technical limitations of the available computer facilities, it seemed appropriate to prepare all of the graphics separately from the text.

The explanatory text in **Part I** provides the necessary background for the historical, literary, scientific and pictorial evidence for the medieval wind-catchers, as well as the relevant bibliography. The graphics in **Part II** can be used either for illustrating the materials discussed in **Part I**, or as a kind of "silent lecture" in itself, whereby **the late pictorial evidence unfortunately predominates over the much earlier literary attestations and poetic delights and astronomical connections**.

In both **Parts I & II** I tend to include many direct citations from other works. This is not only because they contain pithy remarks which are highly relevant to my themes, but also because with just one functioning hand, I find it easier to cut out a paragraph from a text on the internet than to try to summarize it. In the same ways that I have let the medieval authors speak out on the wind-catchers of Cairo and have let the 'orientalist' painters show their paintings featuring these devices, I have also given voice to numerous past and present-day colleagues, mainly serious orientalists. For the past 40 years, the labours of generations of orientalists of divers nationalities have either been ignored (as in Edward Said's *Orientalism*) or have been misrepresented (as in the same work). Readers will have to look hard here for any texts that seek to denigrate or insult the civilization of the Islamic world, and when occasionally some misguided modern writes something silly and false, we should point this out. It may do those who do not like orientalists some good to realize that the orientalists who they have never read or even heard of are not all "bad *hombres*". In this work, I try to say a few words about each orientalist cited.

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The indulgence of the reader is requested for the numerous cases of repetition in this work. Some of these are deliberate and necessary, like "modern *qibla*s are irrelevant in any discussion of the orientation of

historical mosques". I do not care if I write this 1001 times. Others result from the limitations of the software and even hardware used by this hapless soul by mistake, for example, the impossibility of including headers for successive chapters and an index. Instead of an index, the SEARCH function on any computer should work as a substitute. More details of these restrictions are given at the end of the monograph.

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This book-length monograph is not a book in the traditional sense, pursuing clearly-defined goals in each chapter. It is more a set of detailed notes about an architectural feature of medieval Cairo and what this feature can tell us. I have deliberately not submitted this monograph to be published in book form because any publisher would probably want to tamper with the text, which admittedly contains some garrulous chatter, and would certainly baulk at the number of illustrations. Also they would be mainly concerned to profit from the publication, and from the author. By making it available on academia.edu, *The Wind-Catchers of Medieval Cairo* can be freely available to anybody who is interested.

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If we consider all the sources available to us in order to try to reconstruct the history of the Cairene wind-catchers, we can be witness – now for the first time – to a vibrant and highly sensible and evidently efficient means of cooling using natural energy that lasted a millennium until it was cleverly abandoned by *homo modernus* in an attempt to "modernize" the city.

As for the timing of this study in 2019, it was in this year that the disappearance of glaciers in Iceland and Switzerland was announced. The year witnessed young people organized to express their mutual concern about the future of our planet. And much of this monograph was written during a summer in France with staggering temperatures day after day and not a drop of rain for months.

As for the timing of my uploading of this work onto **www.academia.edu** in the Summer of 2020, the Year of الطاعون, *al-ṭāʿūn*, the Plague, I express the hope that this text and all the images from Cairo of yesteryear which

accompany it may provide some distraction from reality and some respite from confinement for all readers.

The title of this monograph

"(The Egyptians) make the opening of their houses exposed to north and the agreeable winds, and one seldom sees houses without a wind-catcher (*bādhāhanj*). These wind-catchers of theirs are tall and wide, and open to every action of the wind; they are erected carefully and with much skill. One can pay between one hundred and five hundred dinars for a single ventilator, but small ones for ordinary houses cost no more than one dinar each." The ʿIrāqī scholar ʿAbd al-Laṭīf al-Baghdādī, who visited Cairo about the year 1200 (my emphasis).

"(The) structure (of the *bādhanj*) inside the house comes to life in the story of the hunchback from the *Arabian Nights*. The hunchback's corpse is carried up to the roof and carefully let down the *bādhanj*, with the result that the owner of the house upon coming home saw a human figure standing in the corner of the wall underneath (inside the aperture for) the *bādhanj*." Franz Rosenthal, "Poetry and architecture" (1977), p. 6.

"On the construction of the base (*maḥilla*) of the ventilator (*bādahanj*). (This chapter includes a discussion of) its (different) names, the quantity of the favourable (north) winds and that of the unfavourable winds (measured) on the horizon circle for that latitude. ... ... If you want to construct it, you have to trace a complete circle and to divide it into four quadrants. Trace a line from the rising amplitude of (the sun when it is in the beginning of) Capricorn to the setting amplitude of (the sun when it is in the beginning of) Cancer for that location. ... ." The astronomer Najm al-Dīn al-Miṣrī, in his monumental survey of astronomical instruments, compiled in Cairo about 1325.

"Many houses (in Cairo) have, at the top, a sloping shed of boards, called a *malkaf*, directed towards the north or northwest, to convey to a *fes-hah* or *fesahah* (an open apartment) below the cool breezes which generally blow from these quarters." Edward W. Lane, *The Manners and customs of the Modern Egyptians* (1895), p. 29.

The title of this study was of course inspired by the name given to the extravagant tales of life in medieval Cairo known as *Alf layla wa-layla*, "The Thousand and One Nights". But it was also influenced by the splendid book *Cairo: 1001 Years of the City Victorious* (1971) by the American sociologist Janet Abu-Lughod, published on the occasion of the millenary of the foundation of Cairo – القاهرة, *al-Qāhira*, "the City Victorious" – in 969, a book which changed the way people looked at Islamic cities. In 1971 I discovered a medieval Egyptian astronomical table for aligning a wind-catcher. This discovery and its consequences changed the way we look at the orientation of historical Islamic religious architecture, in Cairo and throughout the Islamic world. "1001" is also the number of wind-catchers in medieval Cairo – it stands for كتير خاااالص, *ketīr khāāāālis̱*, "many, very many, and even too many". It is also a number favoured by the Foundation for Science Technology and Civilisation in Manchester, an organization dedicating to bringing the history of Islamic science and technology to a wide audience, something the rest of us never achieved. Their main publication is entitled *1001 Inventions: The enduring legacy of Muslim civilisation* in various editions. It is my opinion that the Muslim contribution to world civilisation is important enough, but what the Muslims did for themselves is still far from being properly documented. When we come to talk about astronomy in medieval Egypt, we shall see that virually nothing of that rich tradition was known in the medieval West.

Readers interested only in the wind-catchers of medieval Cairo should ignore the sections of this work marked with the word "Excursus" in their titles, and with these titles in parentheses, for virtually none of these contains useful information on the wind-catchers. Rather, they offer a reflection on the state of modern scholarship, and a background to the astronomical associations of the wind-catchers in the form of a brief overview of the history of astronomy in medieval Egypt. See further below.

Introducing a special kind of academic study

"There's a blank, and something begins to happen, and the hope is

> that it comes through." Lee Krasner.
>
> "All painting is biographical." Lee Krasner.
>
> "At seventy-eight it is time to be in earnest." Samuel Johnson, lexicographer, in *A Journey to the Western Islands of Scotland* (1775) (slightly modified).
>
> "Writing is easy. All you have to do is cross out the wrong words." Mark Twain (1835-1910).
>
> "There are an hundred faults in this thing, and an hundred things might be said to prove them beauties. But it is needless. A book may be amusing with numerous errors, or it may be very dull without a single absurdity. ... ." Oliver Goldsmith, preface to *The Vicar of Wakefield* (1766).

Suppose you have seen a historical wind-catcher or two in modern Cairo, and you decide to write something about these devices. You do not have to go far to find some more examples in early photos and even more in orientalist paintings. Even that would be worth a monograph because these pictures have never been gathered together before. I am saying, nobody has ever done that before! And suppose you then find some references in historical works or some fairly recent articles on wind-catchers in medieval poetry or astronomical texts, let alone an inventory of known examples. The monograph will grow and grow ... .

I am reminded of Dina Ishak Bakhoum's 2016 article "Mamluk minarets in modern Egypt", tracing restoration decisions and interventions. For this Bakhoum needed early or modern photos and historical documentation, which complemented each other. Or Andrew Bednarski's 2005 book tracing the reception of the *Description de l'Égypte* in 19th-century Britain, in which he needed first to describe the work, trace its distribution and reception, and pursue the influence (of its Egyptological sections) in books, journals and the press. The result was a story that had never been told previously. (The Islamic sections have, unless I am mistaken, had far less influence.)

The present study is essentially of the same kind. The aim is to "trace" a particular device over the centuries in architecture and in texts and in paintings and photographs, to write "the cultural biography of that architectural feature". First there was a blank, almost, with the nagging remembrance that I had written on this subject 30 years ago and could not recall anyone ever having taken the work seriously, or having cited it to their advantage. At the end, there was a new monograph, covering over a thousand years of Egyptian history, obviously weak in places and less weak in others.

It is, of course, not possible to write a 'history' of the Cairo wind-catchers. For that reason, I have chosen to organize the textual and graphic materials by author or by artist chronologically in **Part I**, and the paintings and photos by artists and their provenance in **Part II**. Other arrangements are conceivable.

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The deliberately provocative remarks about various modern studies on medieval Cairo which follow stem from various observations over several decades.

First, that the seriousness with which modern academic publications are taken will often depend more on key-words in their titles rather than on any content. Therefore, it is perhaps not a bad idea to occasionally put all the key-words in the title.

Second, that several generations of scholars who concern themselves with the history of Islamic architecture have not been particularly interested in vernacular architecture, and they grudgingly acknowledge new discoveries relating to the orientation of either religious or vernacular architecture. The result has been that these topics have been fallen between the cracks of modern scholarship.

Third, that much previous scholarship is ignored because it is not in the language of the investigator, now mainly English. The situation is inevitably becoming more acute with the presence of the internet. Many people do not know that the language which they choose for their computers dictates what they will find on the internet when they do a

search with, say, Google. Many articles appearing now in German and French, *etc*., are being published by authors who are not familiar with materials already published in English. Much scholarship by Muslim scholars ignores Western scholarship altogether, at the very own risk of the Muslim authors. We shall encounter examples of such trends.

Fourth, that the existence of sites such as academia.edu and ResearchGate.net on which scholars can upload their publications encourages all sorts of interested readers to download even minor publications. However, they will do this mainly if a given publication is announced as "new" or is in any way controversial. Related, more fundamental, more extensive publications already available online on the same sites will not be downloaded.[3]

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[3] My 1975 article on a monumental 14th-century universal table for finding the *qibla* – the most sophisticated trigonometic table between Antiquity and the early modern period – has had 5 downloads on academia.edu, my 1995 article on the orientation of mosques has had 20, and my 2018 article on the absurd Petra fallacy has had 6,000. So virtually none of the people who downloaded the Petra fallacy paper could have learned anything about mosque orientation over a thousand and more years

Another charming example: A paper of mine which appeared on academia.edu as "The sources for early Islamic mathematics" (1979) had the fuller title "Notes on the sources for the history of Islamic mathematics" with a subtitle indicating that it was a review of Fuat Sezgin's 5th volume of his monumental work dealing with (the manuscript sources for) early Islamic mathematics; it attracted 480 views. A paper entitled "Early Islamic astronomy" (1981) with a similar subtitle indicating that it was a review of Sezgin's 6th volume on (the manuscript sources for) early Islamic astronomy attracted 25 views.

It is an annoying fact that much scholarly material is uploaded to these sites without any clear statement of where and when the work was published. (The decline started when it was decided not to put the date on the title-page of a book.) Also, the summaries, unless written by the authors themselves, tend to be garbage, since, as Academia explains: "Our Machine-Learning algorithms scan the text for the most important phrases or passages."

Fifth, that short-sighted academic tradition in the humanities generally forbids or disapproves of the use of images in scholarly writing.[4] Some scholars will publish detailed descriptions of a certain manuscript without including an image of the title-page and/or colophon, and thereby deprive their readers from gaining an idea of what the manuscript looks like and prevent colleagues from recognizing other manuscripts in the same hand. Others will publish detailed studies of a historical architectural feature without presenting a single image. Also, representatives of certain established humanistic disciplines disappear back into their silos when anyone introduces into a discussion new evidence in the form of medieval texts in a strange language (such as Arabic), or new information expressed in numbers of any kind (such as a non-cardinal direction expressed in degrees), or mathematical terminology (such as 'perpendicular'), or new ideas involving the simplest of scientific notions (such as 'winter sunrise').

Sixth, that coincidence plays a decisive role in history. The Ancient Egyptian temple complexes at Thebes, Karnak and Luxor face winter sunrise. The (minor axis of the) orthogonal street-plan of the ancient city of Dura Europos points toward winter sunrise. The minor axis of the rectangular base of the Kaʿba in Mecca faces summer sunrise. The first *qibla* of Cairo was apparently toward due east, the second toward winter sunrise. The Pharaonic / Roman Red Sea Canal lies perpendicular to winter sunrise at the place where the new city of Cairo was built. The minor axis of the new city of Cairo faces winter sunrise. The *qibla* of the Grand Mosque in Córdoba is perpendicular to summer sunrise. The same holds for the basic orthogonal street-plan of Manhattan. Some of these situations were planned, others not. Some of these phenomena are related, others not. Beware! In fact, most of these situations depend more on the

[4] The same goes for academic lectures, which some think should not be illustrated. I once heard a lecture in Frankfurt on Renaissance art in Florence. It lasted an hour and a half and there was not a single illustration. People stayed because of the excellent buffet dinner afterwards.

local water situation or water-course than on urban planning or religious considerations.

Seventh, few people seem to realize that "History" is not something static that one has to study at school. Lists of English kings ... ... , and some creepy kids even learned the dates by heart. "History" is changing all the time, and rewriting "history" requires uncovering new sources and venturing new interpretations. For the history of Islamic science, we are in the fortunate position of having thousands of mainly unstudied Arabic, Persian and Turkish scientific manuscripts at our disposal. And when we study these to find out what Muslim scientists did in the way of science for themselves, we obtain a very different picture from what has previously been the major concern, namely, what 'they' contributed to science in medieval Europe. In fact, 'they' 'contributed' nothing; it was 'we' who helped ourselves to what was available, a very small fraction of the Muslims' total scientific output. How many folk realize that al-Andalus or Muslim Spain was actually something of a backwater as far as science was concerned? The 'action' was taking place in regions far to the east, which had very little influence on Europe.

Eighth, it is a very modern phenomenon that people with no academic or technical training (but sometimes with serious financial or religio-political backing) can establish themselves as experts before an unsuspecting and uninformed public and proceed to push a particular theme which serves their purpose. In this last few years this has happened to, of all subjects, the orientation of historical mosques. We shall meet some of these cranks later on.

Ninth, there are a host of problems confronting anyone who wishes to conduct research in medieval Islamic history. Start with the increasing trend for academic materials to appear on the internet without source or without date or even, sometimes, without author's name. Accessing printed versions of medieval Arabic texts on the internet is, in my experience, a nightmare, especially with multi-volume works. Such books appear sometimes without any search function, which does not make research any easier. Or take the inaccessible digitalized catalogues of Arabic manuscripts proposed on the website of the Library of my *alma*

mater in England; whatever you do, do not press the button labelled 'HELP'. Investigating historical paintings and photographs is a long-term process full of pitfalls. Thousands are available on the internet but the majority are not in any order and are not relevant anyway. Googling individual artists is a good way to start.

Tenth, the *malqaf*s of medieval Cairo, as they are known today, are, as already noted, basically unknown. This may sound silly, because if you google "*malqaf*" in English or in Arabic you get all sorts of stuff about the *malqaf*s of Cairo, mainly mentioning one or two surviving examples. People even exploit the *malqaf* in new ecological architecture.[5] They will tell you that the *malqaf* was known already in Ancient Egypt.[6] They will tell you the *malqaf*s were open towards the favourable winds from the north.

I shall question whether the *malqaf* was indeed known in Ancient Egypt, shall demonstrate that between the 9th and the 19th centuries it was not called *malqaf* but was known by an Arabicized Persian name *bādhahanj* and variants thereof, shall show that it was not oriented to face north but in a direction significantly inclined to the east of north, and shall try to convince that it was used on most buildings in Cairo for over a millennium. This information you will not find so easily on the internet for it is not there.

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In the light of all this, therefore, young researchers are perhaps the sole hope that, in the future, significant architectural features and mosque orientations might be taken seriously. It is mainly to them that the

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5 See the page on "Malqaf" at Global Ecovillage Network: https://ecovil—*—lage.org/solution/malqaf/.

6 New light on the Ancient Egyptian tradition is in Di Nardo & Rossi & Palmero, "From the redrawing of the papyri to the paradigms of passive ventilation in architecture" (2016).

following remarks are addressed, lest the subjects here discussed be forgotten forever.

Some final points: This study is perhaps unusual because on the one side it uses manuscripts, texts, instruments, paintings and photographs to document a 1,000-year-long architectural tradition that was not previously documented, all the while respecting both orientalist writings and orientalist painters. **I am not aware of any other study of orientalist paintings to document any specific historical phenomenon**, but I was both surprised and pleased that the hundreds of paintings I surveyed provided such a rich return. Since Islamic civilization was so tied to the written word, so well served with documentary histories, literary gems, and scientific literature, it is hardly surprising that we find several dozen written references over the centuries to a phenomenon that was attested for centuries in several regions. I have included paintings in which there is even only a single wind-catcher. Also, I have included modern historians who have mentioned wind-catchers once or twice, usually in a sentence or two. Some may regard this as "overkill". Others will quickly establish that I have left out this painting or that, or missed a reference here or there. The assiduous reader will find that there is more to the history of the Cairo wind-catchers than has been recorded here, and surely there will be even more which could contribute to the history of similar devices elsewhere.

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At the outset I must ask the reader's indulgence for my limitations in not being able to survey or even comment sensibly on the history and the architecture and the literature of Islamic Egypt for over a thousand years. In numerous fields relating to main subjects of this monograph, I am out quite of my depth. In my defence, I would claim that the summaries of historical developments involving dynasties and rulers and even economic changes and pandemic events would probably add little to the 'biography' of the wind-catchers. Furthermore, model and eminently readable surveys are available for the history of medieval Cairo (in the introduction to Paulina Lewicka's book on food in medieval Cairo) and its most important suburbs (in Doris Behrens-Abouseif's history of Azbakiyya), its

monumental architecture (in the same author's survey of Mamluk architecture and Nicholas Warner's book on all historical monuments in the city), its medicine (Michael Dols), and its literature (Robert Irwin and Thomas Braun writing on Mamluk poetry and prose). My contribution, beyond the wind-catchers, will be some remarks on the history of astronomy in medieval Egypt, which is barely ever seriously mentioned anywhere. Again, to write the history of astronomy in medieval Egypt would require more than another book, and anyone who would do that has ample secondary literature beyond my own early publications, especially the writings of François Charette and Sonja Brentjes.

If one wants a reliable introduction to many different aspects of the history of Islamic civilization – from the pre-Islamic context, Muḥammad's mission and campaigns, various dynasties such as the Fatimids and the Mamluks and Ottomans, development of city plans such as Cairo, the effects of European colonialism, and recent developments all over the world – the historical atlas of Malise Ruthven and Azim Nanji is recommended. I concur with the authors that history cannot be sensibly related without maps.

My purpose in this monograph is simply to survey the evidence for one particular architectural feature over a thousand years; there is indeed much more source material available than I would have thought at the beginning of this undertaking in early 2019. I would not envy anyone who would undertake a similar survey of courtyards or windows, yet others have succeeded in the case of metal grilles, wooden lattice-work, and funerary encasement decorations. To my good fortune, a major aspect of my present chosen theme is documented in astronomical sources.

I trust that readers will not be put off by this astronomical connection, because the underlying astronomical notion is simple indeed, and it was known to those who built Stonehenge and the temples on the Nile, namely, to pinpoint on the horizon where the sun rises at midwinter. Or one can imagine cutting a cake into 12 equal parts by six diametrical axes: one axis can be north-south, one east-west. The axis at one slice south of east displays the directions of winter sunrise and summer sunset, more or less.

The axis at one slice east of south displays the directions perpendicular to these. And so on ... . More or less ... .

Related to these notions are, on the one hand, the city-plan of Fatimid Cairo and, on the other hand, one of the various *qibla*s that were used in the medieval city. The wind-catchers that I shall discuss have a lot to tell us about the history of the largest city in the Muslim world, information that is not generally known.

A note on chapter-titles in brackets/parentheses (...)

Chapter-titles in brackets (parentheses) indicate materials which contain little material of consequence on the Cairo wind-catchers *per se* or on architectural orientations in Cairo. They relate to materials relevant to the history of astronomy in Egypt (**Chs. 12-13**), presented as a background to the astronomical aspects of the wind-catchers. Or they provide the necessary background to the ways in which Muslims determined the sacred direction or *qibla* (**Ch. 14**). Hardly any of the various modern scholars cited in those chapters (**Chs. 10 & 16**) took the wind-catchers or architectural orientations seriously; their pronouncements are documented mainly for the sake of completeness.

I have removed a substantial section on orientalists and what they have done over the centuries, and some of the ill-founded things that have been written about them by people who have no idea of the scope and depth of their works, since this is, although topical, irrelevant to our main theme.

I have also removed my criticism of the silly pronouncements of those who think they have determined that mosques face some other locality than Mecca. They have cleverly shown that mosques do face other places, but they use modern directions, which were not available centuries ago. My demolition of this nonsense is easily accessible elsewhere.

This text is replete with personal observations that may be of no interest to any reader, but **this subject is one that is very close to the author's heart**. Academic publications are supposed to be impersonal but so many are sterile, often because the subject is or can be of interest only to the author. This is something I have always tried to avoid; I think four years'

teaching in secondary schools helped. Discovering medieval manuscripts relevant to one's chosen research is exciting. The libraries are not round the corner, so it is often an adventure to get to them, and already an achievement to get to them at opening-times. Identifying early paintings and photographs relevant to one's research, I can now testify, is challenging but also exciting. When I began this study in 2019 I had only a paperback of the *Description de l'Égypte* and a book on Gérôme at hand. I hope that the reader will enjoy the results of my labours and even profit from them. Above all, I hope that my affection for Egypt and its peoples will be apparent to everyone. Of all the many authors on Egypt I have cited, it had to be an Italian – Ugo Monneret de Villard – who said **we should proceed with *scienza* and *amore***.[7] He was writing about archaeology, but the same is true for library work with manuscripts or books, and museum work with objects of one sort of another, as well as scouring historic cities for medieval ventilation shafts. Falling down a ventilation shaft can be dangerous, and researching subjects like labour unions is not recommended.[8]

The origin of the Cairo wind-catchers

> "The restrictive character of our sources (– medieval poetry –) raises a number of question for which there are no fully satisfactory answers at present. Does the Persian designation of the *bādhanj* mean that it was imported from Iran, ... ? (This), I think, should be answered with a greatly qualified yes. Even if the *bādhanj* already existed in ancient Egypt, it is possible that it had fallen out of general use and was re-introduced in Islamic times on a large scale. The foreign name of an object certainly suggests foreign origin. ... ." Franz Rosenthal, "Poetry and architecture: the *bādhanj*" (1977), pp. 4-5.

7 See the full quote at the beginning of Ch. 2.

8 https://en.wikipedia.org/wiki/Murder_of_Giulio_Regeni.

> "There is literary evidence in the historical Persian context that a new form of wind-catcher, called "badahanj" from the Persian meaning "drawer of wind", was introduced from Iran to Egypt." Mohammad Amiri-Kordestani, "Natural air conditioning – traditions and trends: high performance of sustainable indoor ventilation in a hot and dry climate", (2013), p. 60, quoting Rosenthal, *op. cit.*, p. 2.
>
> "Based on his studies of the emergence and development of baudgeers, Rosenthal in his work "Poetry and Architecture: the *bādhanj*" believes that this structure was exclusively invented in Iran." Mehdi N. Bahadori & Alireza Dehghani-sanij, *Wind Towers: Architecture, Climate and Sustainability* (2014), p. 41.
>
> "The suggestion (by Franz Rosenthal) that (the wind-catcher) fell out of use toward the end of the end of the Pharaonic Egypt and was imported from Iran in early Islamic times is not persuasive." Robert W. Daniel, *Architectural orientations in the papyri* (2010), p. 143.
>
> "It seems reasonable to posit continuous use of the *malqaf* from Pharaonic into Islamic times. But to date, as far as I know, the remains of Greco-Roman and Byzantine Egypt have yielded no evidence of it." Robert W. Daniel, *Architectural orientations in the papyri* (2010), p. 141.

The origin of the wind-catchers of medieval Cairo has attracted the attention of several scholars, of whom the best informed are cited here.

On the other hand, some others have no right to pronounce on the subject. We find Egyptologists and archaeologists, classicists and Islamicists and Arabists and Iranologists, specialists in this and that, let alone environmental engineers, claiming transmission in this direction or that without knowledge of any texts, discussing words in languages they do not master, or basing their conclusions on a single wind-catcher here or there.

Whoever pronounces on this topic will open themselves to criticism from one interest group or another. I shall not say much.

The wind-catchers of medieval Cairo were not a new invention by some medieval Cairene. There is evidence for wind-catchers in Ancient Egypt. There is evidence from Graeco-Roman Egypt for the use of wind-catchers. There were wind-catchers on Coptic buildings before the advent of the Arabs. There were wind-catchers in Fustat before the foundation of the new city of Cairo in 969, even if what they looked like is unclear. So why did the wind-catchers of medieval Cairo-Fustat have a Persian name, *bādahanj*? (I have to keep repeating that the word *malqaf* for wind-catcher is not attested before the 19th century. In the medieval period that word meant something else.)

The land of wind-catchers is Iran. They are still there. They have been treated with respect. But how long have they been there?? Those we can see in Yazd today do not pre-date *ca*. 1850. The Cairo wind-catchers did not come from Iran. Wind-catchers are attested in Baghdad, Aleppo and Damascus in the 10th century, and they were also called *bādahanj*. The link from Iran to Iraq is easy to imagine. The link from Syria to Egypt is likewise easy to imagine. But there are other influences: Iranian craftsmen came to the thriving international city of Fustat, and the vocabulary of building construction there was replete with Persian words (and remains so to this day).

I have no intention of delving deeply into the origin of wind-catchers and their transmission. Readers should keep in mind that we are dealing with uni-directional wind-catchers, and it is only reasonable to install such devices in locations where there is a favourable wind from one specific direction.

Future researchers will be well-advised to start with Jaubert 1995 and Daniel 2010, as well as the work of Iranian scholars which I am about to summarize.

Remarks on the history of wind-towers in Iran

> **"(Illustrations of) numerous wind-towers in Iran, called in Persian as *bādgīr*s. Iran, with its indigenous culture dating back millennia, has the richest tradition of any country on earth of**

water-conservation and control for agricultural and domestic use (*qanāt*s) and wind-utilisation (*bādgīr*s) and natural refrigeration and ice-production (*yakhchāl*s).” DAK, caption to **Pl. V2** in **Part II**.

“Because the oldest wind catchers in Iran only date to the 14th Century, their place of origin is a subject of dispute between Iran and Egypt.” Shervin Abdolhamidi, “An ancient engineering feat that harnessed the wind”, BBC 27.09.2018. (I am not aware of any serious discussion of this topic by anybody familiar with both traditions.)

Susan Roaf, lecture “The amazing wind catchers of Yazd” at the Iran Heritage Foundation in London (iranheritage.org) on 04.03.2020. (The amazing wind-catchers of Cairo will have to wait.)

At the outset I must explain that I shall not be discussing in any detail wind-catchers in Iran, or rather ‘Greater Iran’ – **Pls. V2-V4**. (By that expression I mean the world of the *bādgīr*, from Iraq to as far away as Pakistan and the world of the Iranian immigrants on the other side of the Gulf who brought this technology to what now constitutes the Emirates.) There are two main reasons for this. One is that there exists a plethora of literature on these wind-towers, to which I have nothing to contribute. Most of this literature has been published by engineers with little interest in presenting historical information. The other is that surprisingly little seems to have been written by anyone on the history of these devices, and I am not the person to write anything beyond a brief summary of what is known. Also, I shall mention wind-catchers in Ancient Egypt in **Ch. 2**.

Out of several hundred books and articles on the *bādgīr*s, listed in **Section VIIIf** of the bibliography, there is only one that I have found which deals seriously with the history of these devices. This is the book *Wind Towers: Architecture, Climate and Sustainability* (2014) by Mehdi N. Bahadori &

Alireza Dehghani-sanij, the former author having been publishing on wind-towers for many decades.[9]

The authors begin with a claim that *bādgīr*s date back 1,500 years, inevitably without indication of any source, and that they spread even to North Africa, presumably meaning Egypt. They cite Franz Rosenthal's article as evidence that the Egyptian *bādahanj* was invented exclusively in Iran, but Rosenthal was also aware of the Ancient Egyptian connection and opted for the Iranian origin only on account of the Persian name that was used in medieval Egypt.[10]

Several Iranian poets from the 9th century onwards mentioned the *bādgīr*. A historical text from the 15th century mentions "a four-storey terrace on one side of the castle with four *bādgīr*s on its four sides" and "a superb house with two lofty *bādgīr*s". Three well-known visitors to Iran are quoted.

First, the Venetian world-traveller Marco Polo (1254-1324) recorded that:

> "To fight against scorching heat prevailing in the region, all houses are equipped with *bādgīr*s in order to harness the wind. A *bādgīr* faces the wind flow and the wind is led into the house."

Second, the Spanish diplomat García de Silva y Figueroa (1550-1624) was sent to Iran as ambassador of Spain in 1614 and wrote a whole page of informative text about the *bādgīr*s, saying *inter alia* that:

> "the *bādgīr*s work like fans and their structures are like fire-places in our homes."

Third, the French gem-merchant and traveller Jean-Baptiste Tavernier (1605-1689) visited Iran several times and wrote:

> "From Lar to Hormoz, all the houses have identical plans. All have a

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[9] Mehdi N. Bahadori & Alireza Dehghani-sanij, *Wind Towers: Architecture, Climate and Sustainability* (2014), pp. 41-61 ("The history of baudgeers").

[10] Rosenthal, "Poetry and architecture: the *bādhanj*" (1977), pp. 2 & 4-5.

bādgīr which stretches from the basement of the house to the roof to cool the interior. However, for strangers who are not accustomed to the climate of this country, sleeping indoors, next to these structures, is unhealthy."

Actually, the small town of Lār is important in Iranian history, not least because it has retained its *bādgīr*s and its medieval appearance.[11]

Our two authors cite numerous 19th- and 20th-century travellers who mentioned the *bādgīr*s, including some mentioned by Susan Roaf in her 1988 doctoral thesis on the imposing *bādgīr*s of Yazd, and they present the various illustrations in the historical travel literature. They then turn to the Egyptian poets whose references to the *bādahanj*es in Cairo were translated by Franz Rosenthal. And finally they mention the Bastakīs from Bastak in Iran who some 120 years ago founded a colony in Dubai and brought the technology to the other side of the Gulf.

It is worthy of note that the British Orientalist Guy Le Strange (1854-1933) in his *Lands of the Eastern Caliphate*, first published in 1905, which is based on Muslim geographical works and travel accounts up to *ca*. 1400, does not mention any *bādgīr*s in Greater Iran.[12]

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A digression to explain why the wind catchers of Yazd are there, and why they are so splendid. As far as I know, these reasons are not found in the literature on the *bādgīr*s.

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[11] Article "Lār" by the French scholar of Iranian Studies, Jean Calmard (1931-2017), in *Enc. Islam*, 2nd edn., esp. V, 665b. On some previously unrecorded scientific activity in Lar in the 16th and 17th centuries, see King, *World-Maps for finding the direction to Mecca* (1999), pp. 221-223 & 449.

[12] Le Strange, *The Lands of the Eastern Caliphate – Mesopotamia, Persia, and Central Asia from the Muslim conquest to the time of Timur* (1905).

The appearance of the remarkable wind-catchers in Yazd can be related to two independent but simultaneous international developments,[13] besides the fact that they are clearly a good idea. In Yazd, some 1,800 weaving factories employing about 9,000 workers were counted in the 1850s before the silkworm crisis. The silk industry in Isfahan, Kashan and Yazd flourished until *ca*. 1850, as a result of a silkworm disease which spread to Iran from Europe. Since the 15th century, raw silk had been produced in several regions of France, the main centre of preparation and distribution being Lyon. (Actually the first written record of silkworm breeding comes from the Cévennes region of France and is dated 1296. In this author's house in the Cévennes, there is a *magnanerie* of some 60 m^2, in which before *ca*. 1850 wooden frames were hung from the rafters to accommodate the silkworms.) As a result of the disease, the silk industry collapsed in France and Iran and elsewhere.

Shortly afterwards, the opium market began to flourish in Iran and more money became available. Guillaume-Antoine Olivier, who travelled in the Middle East at the turn of the 19th century, noted that "opium in Iran was like wine in (southern) Europe: although it was abundantly available, few drunks were seen in public." The size of the new *bādgīr*s in Yazd reflected the wealth of the merchants who had them built.

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[13] The influence of the silk trade then the opium trade on Yazd and its *bādgīr*s is discussed in Susan Roaf, "More lessons from the Windcatchers of Yazd" (2008).

On the history of silk production and trade in the Islamic world in general see the article "Ḥarīr", in *Enc. Islam*, 2nd edn., and on silk in Iran see sections of the article "Abrīšam (silk)" by M. Bazin & C. Bromberger in *Enc. Iranica* (1983/2011) at www.iranicaonline.org/articles/abrisam-silk-index.

On the history of opium production and use in Iran see the article "Afyūn (opium)" by S. Shahnavaz in *Enc. Iranica*, at www.iranicaonline.org/articles/afyun-opium, and also Regavim, *The Most Sovereign of Masters: The History of Opium in Modern Iran, 1850-1955* (2012).

Almost a thousand survive in Yazd to this day. The reason why they are still there and the ones in Cairo have gone surely has partly to do with the fact that Iran was never colonized by a foreign power.

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If the historical chapter by Mehdi N. Bahadori & Alireza Dehghani-sanij, two engineers, is the only available history of the *bādgīr* in Iran, and I repeat that it is the only one I have found, then there is perhaps need for a doctoral student, in literary and/or historical studies rather than environmental engineering or architecture, to take the subject to a new level. Certainly Olivier Jaubert, expert on Cairo wind-catchers, but also on pre-Islamic Egyptian devices, has produced some as yet unpublished materials uncovering previously-unknown similarities between Egyptian wind-catchers and devices for the same purpose in off-the-beaten-track Iran and Central Asia.[14]

What is clear is that the fate and fortunes of the *bādgīr*s in Iran and the fate and fortunes of the *bādahanj*es in Cairo are not dissimilar from a historical point of view. Their history can be reconstructed from literary references by local and foreign scholars, by images made by Western travellers, and by poetry over the centuries, in addition to what remains of these edifices. The difference is that the *bādgīr*s of Iran are still there and everybody knows about them, and the *bādahanj*es of Cairo have virtually all been demolished and nobody but a small circle of scholars knows that they were ever there. To put it in modern terms, the *bādgīr*s of Iran are all over the internet, and the *bādahanj*es of Cairo are not.

Of all the Iranian wind-catchers known from the literature and from the internet, those still visible in Maybud, a small town some 50 km NW of Yazd, look closest to the Egyptian ones – **Pl. Q14**.[15] First, they are uni-

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14 Several of Jaubert's research reports are listed below in the bibliography after his 1995 survey of Cairo wind-catchers.

15 Image gratefully taken from Dehghani-Sanij & Soltani & Raahemifar, "A new

directional. Second, they have either flat roofs or sloping roofs. However, the scoops are not constructed out of wood.

Vernacular architecture being deliberately demolished

> "Cultural heritage or useful technical device? Now the question is, if windcatchers work so well then why are they so rare today? Pakistan today is in an energy crisis, and relying on mechanical air conditioning devices is difficult and expensive because of frequent power cuts. **Passive cooling techniques like windcatchers could substantially improve people's comfort – especially for those who can't afford mechanical air conditioning. In my opinion, the problem has a lot to with the image people have of what's modern and what's seen as backward. Windcatchers are seen as something old and a part of cultural heritage, not as a technical device that could be used today.** The few modern buildings that had windcatchers – the district administration's office and the Aga Khan Maternity Hospital – only had decorative windcatchers. But if modern buildings like these would use windcatchers that were both functional and aesthetically pleasing, it could raise the status of the technique considerably, contributing to a more comfortable and energy efficient built environment." Erika Alatalo, "Searching for windcatchers in Hyderabad" (2016) (my emphasis).

There are numerous examples one could cite of vernacular architecture in the Muslim world being deliberately destroyed. Three must suffice here to set a background for the disappearance of the Cairo wind-catchers.

First, we turn to the province of Sindh, in present-day Pakistan, and the city of Hyderabad, which was founded in 1768. In 1815 a British traveller "Patinger" (*i.e.*, Henry Pottinger, an Anglo-Irish soldier and colonialist administrator) reported:

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design of wind tower for passive ventilation" (2015), p. 183.

> "All the houses of the government palaces to the humble cottages have wind catchers."

A. S. Bazmee Ansari reports in the article on Hyderabad in the *Encyclopedia of Islam*:[16]

> "The old town, built in a haphazard way, consists of narrow lanes and bystreets lined with dingey, old-fashioned, many-storeyed houses. A peculiar feature of these houses is that they carry on their roof-tops strange-looking contraptions for catching the sea-breeze blowing from Karachi. These wind-catchers deceived Sir Charles Napier, during his victorious march on Sind, into taking them for small guns."

('As every schoolboy knows .... ', Napier is popularly believed to have sent in 1843 a telegram to his superiors in London with only the Latin word "*peccavi*" – I have sinned – in order to indicate that he had captured Sind. However, this gem, which first appeared in *Punch Magazine* in 1844, is fiction. Historians loved the story because it captures the mischievous personality of Napier and, more importantly, the morally-questionable nature of his blatant annexation of hitherto independent territory to the British Empire. What Napier did write elsewhere was quite frank: "Our object in conquering India, the object of all our cruelties, was money."[17])

In the *Gazetteer of Sindh* published in 1907, it is mentioned that:

> "in rural houses of the old type, windows are regarded as superfluous but wind sails through the roof (*mangh* or *badgir*) are very common and almost a necessity."

These wind-catchers in Hyderabad, called *manghu* in Sindhi, remained an integral part of domestic architecture – **Pls. V1 & W3a** – until electricity was introduced by the British during the early 1940s. They were then

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16 Bazmee Ansari, article "Ḥaydarābād (Sind)", in *Enc. Islam*, 2nd edn.

17 Information from https://www.historyextra.com/period/sir-charles-napiers-sin/.

mainly replaced with electric fans and later with air-conditioning. The city used to be known as *manghu-ju-shahur*, “City of Manghus”. Wind-catchers on various modern buildings in Hyderabad are purely decorative.[18]

Second, the destruction by the local authorities of the few remaining old houses of Mecca to produce new buildings intended to accommodate the ever-growing numbers of pilgrims and expand the reception facilities, which include luxury hotels and shopping-complexes. Along with those fine old houses go the elaborate *mashrabiyya*-type projecting wooden screens (رشان, *roshān*, pl. رواشين, *rawāshīn*) over the facades of the buildings, protecting them like garments.[19] This is actually just part of a deliberate Saudi campaign to obliterate the nation’s past in a way that defies comprehension.[20]

One just has to turn on the television news to see scenes of wanton destruction in Afghanistan, Iraq and Syria. The effect of war on the historical architecture of these countries pales in comparison with the suffering that has been inflicted on the local inhabitants. As a third example I shall mention only one other country which, before it too was

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18 See Talpur, “The vanishing glory of Hyderabad” (1958), pp. 56 & 59; also www.insideflows.org/project/ancient-wind-catchers-in-hyderabad/; also Alatalo, “Searching for windcatchers in Hyderabad” (2016), at www.fieldstudyofthe—*—world.com/searching-windcatchers-hyderabad/.

19 Al-Murahhem, “The mechanism of the rawashin: the case study of Makkah” (2010), and other publications by the same author.

20 www.nytimes.com/2014/10/01/opinion/the-destruction-of-mecca.html?_r=0, and https://en.wikipedia.org/wiki/Destruction_of_early_Islamic_heritage_s—*—ites_in_Saudi_Arabia, and, more recently, Atef Alshehri, “Mecca and Medina – sacred sites or development engines?” (2019).

(It is somewhat ironic that the Saudis now seek to profi t from overseas tourists visiting the Nabataean sites in the Kingdom. At least there will be fewer visitors to the Ancient Arabian sites in Yemen.)

violated, was known to just a few specialists and real travellers of the 19th-century variety. I refer to the Yemen, whose priceless and unique historical, cultural and architectural heritage has suffered immeasurably from internal and external aggression – even my own country supplied some of the weapons. International awareness of the situation regarding historical architecture in the Yemen, most of which could be classed as vernacular, has been aroused. I refer, for example, to a 2017 volume of studies appropriately edited by Trevor H. J. Marchand and entitled *Architectural Heritage of Yemen*, and the same author‘s 2017 essay "Yemen‘s architectural heritage under threat", as well as the 2018 doctoral dissertation of Xochilt Del Rosal Armenta, *Heritage Preservation in War: Proactive and Reactive Approaches Applied to the Old City in Sana'a.* If one compares these writings with the beautifully-illustrated 1990 volume *The Yemen – 3000 years of art and civilization in Arabia Felix* edited by Werner Daum, one will be brought to tears, unless, of course, one is in the arms business. The German diplomat and historian, Werner Daum, had asked me to contribute a chapter for that volume on the history of astronomy in Yemen over a thousand years, which nobody knew about.

Introductory remarks on the orientation of Islamic religious architecture

> "Every mosque in the world is a segment of a circle whose centre is the Kaʿba. **The most significant characteristic of the mosque is the direction that it faces.** Hence it is the building's abstract orientation and not its most visible elements – dome, minaret, mihrab, etc. – that determines its identity.'' H. Masud Taj, "Facing the city: the influence of qibla on street-line orientation in Islamic cities'' (1999), p. 173. [This is a message from a Muslim architect for all those who write on historical Islamic architecture ignoring its most significant characteristic. The emphasis is mine.]

> "Depending on the time period and cultural context, the architectural forms and styles of Islamic mosques vary widely. **All mosques, however, share specific requirements. Chief among these is orientation. All Islamic mosques worldwide are**

oriented as closely as possible to the direction of the holy city of Mecca. All Muslims throughout the world pray in the direction of Mecca and perform their prayers ... in the direction of the *qibla* (the wall of the mosque that is oriented to Mecca) and the *mihrab* (a niche in the *qibla* wall). A *qibla* and *mihrab* are thus among the requirements for Islamic religious architecture." Leslie Ross, *Art and architecture of the World's religions* (2009), pp. 151-152. (Correctly stated; my emphasis. In the present study we shall find out what "as closely as possible to the direction of ... Mecca" means.)

The Bible rightly says that it begins at the beginning, at least at the beginning of *Genesis*. I cannot resist the temptation here to begin at the end, just to give the reader an idea of where we are heading. Then we will turn to the wind-catchers of medieval Cairo, which point the way to that end.

The sacred direction in Islam is toward the sacred shrine of the Kaʿba (Arabic كعبة) in Mecca. The Kaʿba is the physical focus of Muslim worship, considered by Muslims to be a pointer to the presence of God. The direction of the Kaʿba is called *qibla* in Arabic and all the languages of the Islamic commonwealth. The *qibla* is indeed the sacred direction, because Muslims observe it in prayer, communal and private, and in many ritual acts up to burial. All religious architecture is oriented in the *qibla*, facing the Kaʿba. The Kaʿba is an ancient edifice whose rectangular base is astronomically aligned, a fact unknown to most Muslims nowadays but documented in various medieval Arabic texts. It has been destroyed by flooding and rebuilt several times over the centuries but I would maintain that its orientation is almost as sacred as the Kaʿba itself and has not been changed over the centuries.

Of all human civilizations, the Muslim endeavour was the most concerned with orientations, and this for almost 1,500 years. This makes the neglect of architectural orientations in writings on Islamic religious architecture the more surprising. For while all Islamic religious architecture is aligned toward the Kaʿba, people write books about this architecture without mentioning the *qibla*, let alone the Kaʿba. The main reason they do this is

because they have no idea of the ways in which the Muslims over the centuries oriented their architecture toward the Kaʿba, and they have also heard that some historical mosques do seem not to be aligned towards Mecca. These techniques are documented in the modern literature. We know, more or less, how Muslims oriented their mosques centuries ago.

Some people still think that this is a taboo subject because historical Islamic architecture is never actually oriented in the modern *qibla*, except by coincidence. Some Muslim scholars are confused because they think that Muslim scholars in the medieval period knew how to find the *qibla* precisely. They did, but it was not the modern *qibla*. If they calculated the *qibla* at all, they based their calculations on medieval geographical longitudes and latitudes, which were less accurate than modern coordinates; often the longitudes were particularly problematic. So even when they determined the *qibla* using exact mathematical methods, the result would not be the modern *qibla*. It would be pointless to compare historical mosque orientations, laid out by medieval procedures, with modern directions toward Mecca, which are irrelevant to medieval architecture. It would make more sense to look at the ways Muslims determined the *qibla* in ages past, a topic on which there is a mass of published material.[21]

The problem with the history of the *qibla* is that everybody thinks they know what the *qibla* is. "It must be, more or less, in that direction ... , yes, just about south-east from Frankfurt ... ." But, from a historical point of view, it is not so simple. Add to this the fact that moderns will tell you that the *qibla* is "the direction of Mecca". **The *qibla* is NOT the direction of Mecca; it is the direction of the Kaʿba.** How one is to face a distant edifice is not so obvious.

Over the centuries, Muslims found the *qibla* in different localities first using the methods of folk astronomy and sacred geography, namely, using

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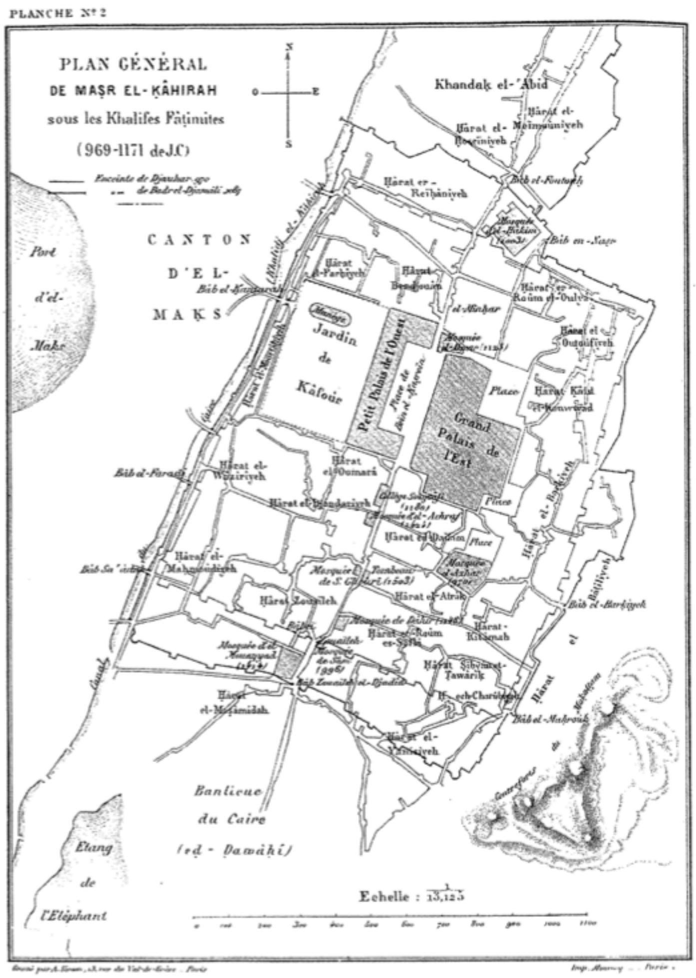
21 Some 150 articles and books are listed in King, "Bibliography of books, articles and websites on historical *qibla* determinations" (2018).

astronomical risings and settings because **the Kaʿba itself is astronomically aligned** (**Ch. 13**). From the 9th century onwards, they also sometimes determined the *qibla* using mathematical procedures applied to (medieval) geographical coordinates (**Ch. 14**). In each major centre, including Cairo, there was a palette of different directions used for the *qibla*, each one used by different interest groups (**Pls. T14 & U6**). In other words, historical mosques face those directions which their builders or patrons thought was the *qibla*. Later (in **Ch. 15**) I shall concentrate on medieval Cairo, which, as we shall see, is one of the most interesting examples of an Islamic city oriented with respect to the Kaʿba.

Date-line for Egypt

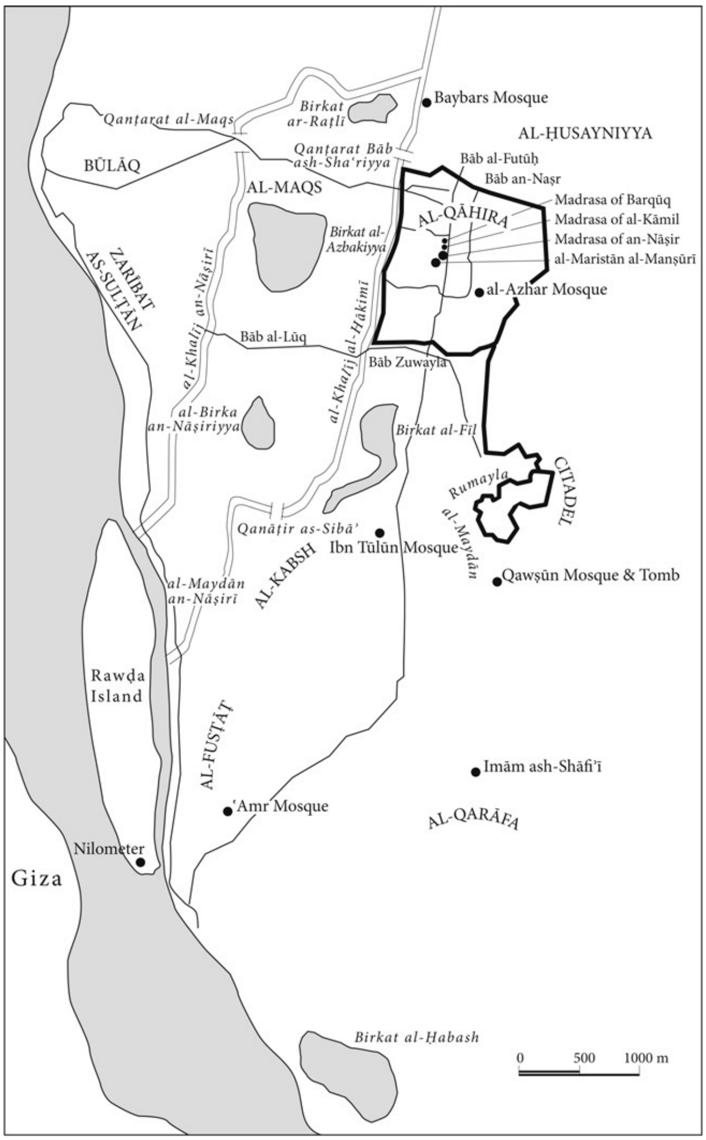
Muslim conquest	643
(Islamization & Arabicization begin)	
Occupation of Fustat	643 – 1168
Rāshidūn / Umayyads / Abbasids / Tulunids / Ikhshidids	641 – 969
Fatimids	909 – 1171
Foundation of al-Qāhira	969
Ayyubids	1169 – 1252
Mamluks	1252 – 1517
Ottomans	1517 – 1867
French occupation	1798 – 1801
Line of Muḥammad ʿAlī	1805 – 1953
British occupation	1882 – 1922
Republican self-government	1953 –

Notes: See the article “al-Ḳāhira” in *Encyclopaedia of Islam* (1974) by J. Michael Rogers, with a map of major edifices in the medieval city. On the dynasties see C. Edmund Bosworth, *The New Islamic Dynasties* (1996).



A reconstruction of the plan of
Fatimid Cairo by Paul Ravaïsse (1860-1929),
historian and orientalist.

A map of medieval Cairo by Paulina Lewicka showing various suburbs (from her *Food and Foodways of Medieval Cairenes*) after Amalia Levanoni.



2 — Published writings on the Cairo wind-catchers

The basic documentation of historical Cairene architecture

> “The Mamluks were strong patrons of scholarship. Medieval Islam’s greatest historian, Ibn Khaldūn (1332-1406), was a native of Tunisia, but he spent his later years in Cairo where Sultan Barqūq made him a chief judge. “What one can imagine always surpasses what one sees,” Ibn Khaldūn once wrote, “because of the scope of the imagination, except Cairo because it surpasses anything one can imagine.” Ibn Khaldūn had seen too much of the world to be easily impressed, but Cairo clearly took his breath away: “**He who has not seen Cairo knows not the glory of Islam, for Cairo is the metropolis of the world, garden of the universe, meeting place of nations, human ant-hill, heart of Islam, seat of power.** Here are palaces without number, and everywhere flourishing religious colleges and convents for mystics, while its scholars shine like dazzling stars. The city stretches over the banks of the Nile, river of paradise and receptacle of the rains of heaven, whose waters quench men’s thirst and bring them abundance and wealth. I have walked its streets: they are thronged with crowds, and the markets are overflowing with every kind of merchandise.” ” Jason Thompson, *A History of Egypt: From earliest times to the present* (2008), pp. 200-201 (my emphasis), quoting Ibn Khaldūn’s autobiography.

> “Egypt and Cairo have long been at the geographic and cultural center of the Arab world. Cairo in the Middle Ages was, as it is today, one of the world’s most populous cities. Unlike Baghdad or Damascus it was never sacked by invaders, and its primary position under the Tulunids, Fatimids, Ayyubids and Mamluks has resulted in an architectural legacy unequalled in the Arab world. The momentum that this created meant that even under the Ottomans it was a prosperous center of construction and trade. Its resurgence as

> an intellectual and cultural center in the Middle East has continued from the time of Muhammad ‘Ali to the present day. Even if the legacy of recent years is outshone by those of previous centuries, its panorama of mosques from the earliest days of Islam to the present is unrivalled.” Bernard O’Kane, *The Mosques of Egypt* (2016), p. xliv.

> “Bisogna ricordare che l’Oriente è paese dalle molte vite e dalle molte storie, e che in ogni località si sovrappongono strati di diverse civiltà; che l’archeologo deve scavarli tutti e studiarli con eguale amore e con eguale scienza.” / “We must remember that the Orient is a place of many lives and stories, and that in every area layers of different civilizations overlap; the archaeologist must excavate them all and study them with equal love and equal science.” Ugo Monneret de Villard (1881-1954), “La missione archeologica italiana in Egitto, 1921-28” (1928), p. 270, reported in Silvia Armando, “Monneret de Villard and Islamic Art studies in Italy” (2013), pp 39 & 63, n. 37.

We begin with the **Comité de Conservation des Monuments de l’Art Arabe (**Committee for the Conservation of the Monuments of Arab Art), established in 1881 by Khedive Tawfiq (*reg*. 1879-1892), which was responsible for the preservation of Islamic and Coptic monuments. It was an Egyptian institution, part of the Ministry of Charitable Endowments (*Awqāf* in Arabic), but is often referred to by its French title.

The Comité was established partly in response to the neglect and occasional destruction of medieval Cairo which had begun over the course of the 19th century under the regime of Muhammad Ali and his successors, who attempted to modernize Egypt through projects including the construction of new areas of Cairo that followed a European model. French archaeological enthusiasts had helped publicize the issue in France, which created pressure on the Khedive. French architects at that time had not so long before participated in the ‘embellishment’ of what remained of medieval Paris.

The Comité’s tasks, split between two sub-committees or commissions, was first to index every Islamic or Coptic monument in Egypt, assess

which ones were in need of attention, and then recommend a course of action. Decisions were made based on the monument's condition at the time as well as its architectural or artistic value.

As chief architect to the Comité, the Hungarian architect Max Herz (1856-1919) directed the conservation of monuments of Arab-Islamic and Coptic architecture all over Egypt, first of all in Cairo from 1890 until the end of 1914, when he was thrown out by the British.[22] **The list of close to three dozen monuments restored or rescued by Herz is impressive indeed; if one person deserves the honour of having saved medieval Cairo for posterity, it is Max Herz Pasha.**[23]

It is worthy of note that of all the buildings restored by Herz that are illustrated with early photos in the Wikipedia article "Max Herz", none features a wind-catcher. In the present monograph we shall constantly be confronted with the reality that in centuries past, houses invariably had wind-catchers and religious monuments sometimes had them. Also this monograph is essentially about Cairo in Fatimid and Mamluk times, not the Cairo that spilled over into Ottoman times, and for the Cairo that had to be fixed up by Max Herz Pasha we have images collected in **Part II.**

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[22] On the Comité see the detailed article "Max Herz" in Wikipedia, also the brief article "Comité ... ", both anonymous. I have used these articles for this paragraph. The former contains a list of the monuments rescued by Max Herz. For a fuller treatment see István Ormos, *Max Herz Pasha 1856–1919 – His life and career* (2009). The Comité became part of the Ministry of Education in 1936, and was formally dissolved in 1961. Its responsibilities passed to a Committee for Islamic and Coptic Monuments under the Egyptian Antiquities Organization.

On the reports of the Comité see Warner, *Monuments of historic Cairo* (2005), p. 82, and www.islamic-art.org/comite.asp.

[23] Anonymous, **"Max Herz Pasha: the man who saved Cairo**", *CairObserver* 10.09.2012, a review of István Ormos' book mentioned in the previous note.

In the 19th century art enthusiasts were more interested in Islamic art and decoration and also in inscriptions than in Cairene architecture *per se*. Witness the various albums of Islamic designs that were published at that time. It was in the early 20th century that mainly French and English scholars turned their attention to documenting Cairene architecture scientifically, an operation which continues to this day.[24]

In 1869 the Danish orientalist and philologist August Ferdinand Mehren (1822-1907), best known for his work on Arabic rhetoric and linguistics, had already prepared a handlist in French of some 70 religious monuments in Cairo.[25]

The book *Les mosquées du Caire* was published in 1932 by the French scholars Louis Hautecœur (1884-1973) and Gaston Wiet (1887-1971). The former was a government official and specialist in French art, not a specialist in Islamic architecture. The latter was an orientalist and specialist in Islamic architecture; he served as Director of the Museum of Islamic Art in Cairo from 1926 to 1951, and authored almost half of the 35 volumes of the catalogue of its collections.

The British scholar, K. Archibald C. Creswell (1879-1974), based in Cairo, mainly at the American University in Cairo, published the monumental two-volume *Early Muslim Architecture* (1940), and two-volume *The Muslim Architecture of Egypt* (1952-59). He laid the foundations for future investigations by Anglophone scholars.

In the 20th century a series of French scholars based at the Institut Français d'Archéologie orientale in Cairo were also involved in the basic documentation of Islamic architecture in Cairo. These scholars tended to

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[24] For an overview, now in need of updating, see Rogers, article "al-Ḳāhira" in *Enc. Islam*, 2nd edn., IV (1978), pp. 438-441. See also Nicholas Warner's new book mentioned below.

[25] Mehren, "Tableau général des monuments religieux du Caire" (1869), recently reprinted.

concentrate on the *palais et maisons* of the city rather than the mosques, madrasas and mausolea. One of the first was Alexandre Lézine (1906-1972), to whom we shall return. We should also mention Edmond Pauty (~1890-~1960), Jean-Claude Garcin (d. 2017), Bernard Maury (1943-2005), Jacques Revault (1902-1986), Mona Zakariya, and also the celebrated André Raymond (1925-2011) as the contributors to this series. The disadvantage of a flurry of volumes with similar titles appearing over the decades is outweighed by the fact that they are now available for free on the internet.

The German scholar Michael Meinecke (1941-1995), based at the Deutsches Archäologisches Institut in Cairo, and in the 1940s born a week before this author and in the 1970s living as close friends and neighbours, produced a fundamental documentation of Mamluk architecture in his *Die mamlukische Architektur in Ägypten und Syrien (1250-1517)* (1992).

Individual architectural complexes or buildings were documented scientifically by such scholars as Eustace Corbett, Christel Kessler, Jonathan Bloom, Caroline Williams, Eleonora Fernandes, Stephennie Mulder, Nasser Rabbat, Bernard O'Kane, and others. The detailed 2007 overview of Mamluk architecture by the Egyptian-born London-based scholar Doris Behrens-Abouseif deserves special mention. An overview in the form of a catalogue of all historical monuments in Cairo, viewed in the light of their physical situation in the city and with extensive bibliography on each building complex, was published in 2005 by the American architecture historian Nicholas Warner.

We shall return to all of these works later.

The Cairo wind-catchers enter the modern literature

> "En Égypte, l'ouverture au sommet du conduit est unique, car le vent dominant souffle toujours du nord ou du nord-ouest. Il n'est pas de même ailleurs." / "In Egypt, the opening at the top of the air-duct (in a fixed direction) is unique, because the (favourable) wind always blows from the north or from the north-west. It is not the same elsewhere." Alexandre Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971), p. 13.

"In a photograph by Francis Frith of 19th-century Cairo, the rows upon rows of air shafts on the roofs of houses have an aesthetic appeal similar to that of a forest of television antennas extending today into the sky over a modern city. The orderliness and symmetry of the air shafts suggest a certain harmony and quiet, while the television antennas in all their different sizes and jagged shapes seem to reflect just the opposite, a restlessness and confused spirit of competition, which is, perhaps, expressive of the mood of our times." Franz Rosenthal, "Poetry and architecture: The *bādhanj*" (1977), p. 1.

"Le capteur de vents est présent dans de très nombreux bâtiments et monuments de types et fonctions très différents. Son emploi était très répandu et vraisemblement partagé par les représentants de toutes les classes de la société égyptienne. Il est un simple auvent de bois, posé en toiture, audessus d'une ouverture dans les constructions les plus humbles. Dans les monuments de prestige, le capteur de vents devient un ouvrage complexe nécessitant l'intervention d'artisans spécialisés. Le capteur de vent est dans son principe très simple." / "The wind catcher is present on very many buildings and monuments of very different types and functions. Its use was very widespread and apparently shared by representatives of all classes of Egyptian society. In the humblest constructions it consists of a simple scoop placed on the roof above a (vertical) opening. In prestigious monuments, the wind-catcher becomes a more complex work necessitating the intervention of specialized craftsmen. The principle of the wind-catcher is very simple." Olivier Jaubert, "Capteurs de vents d'Égypte" (1995), p. 213.

" "Orientalism" is a way of seeing that imagines, emphasizes, exaggerates and distorts differences of Arab peoples and cultures as compared to that of Europe and the U.S. It often involves seeing Arab culture as exotic, backward, uncivilized, and at times dangerous. Edward W. Said, in his groundbreaking book, *Orientalism*, defined it as the acceptance in the West of "the basic distinction between East and West as the starting point for elaborate theories, epics, novels, social descriptions, and political accounts concerning the Orient, its people, customs, 'mind,' destiny and so

on.” ” Evelyn Alsultany, “What is Orientalism?” (n. d.). (It has come to this! So far, orientalists, whose work was only vaguely known to Said, have acknowledged that the people who used wind-catchers were smart.)

A growing interest in heat control in Ancient and medieval Egypt

All of the scholars just mentioned documented the existence of wind-catchers when and where they found them. However, one gets the feeling that the first scholars to document historical Cairene architecture in the 20th century were not quite sure what they were dealing with when they encountered the occasional wind-catcher. And when some local told them these were *malqaf*s, they adopted that word, starting a tradition of mis-nomenclature which has lasted over a century. The specialists only began to realize that the devices were actually called *bādahanj*es when they encountered this word in the *waqf* documents – see the end of **Ch. 4**. This term was, of course, also attested in the medieval literary and astronomical sources but these were still un-researched.

The first scholar to have turned his attention to heat control in Near Eastern architecture was the Egyptian-born archaeologist Alexander Badawy (1913-1986), professor of art history at the University of California at Los Angeles. In 1958 he published a survey of traditional Ancient Near Eastern cooling techniques, concentrating on Ancient Egypt, Iraq and Iran.[26] The situation in medieval Egypt and Iraq is mentioned only in passing.

In 2013 the French Egyptologist Franck Monnier recently proposed a new interpretation of a hieroglyph inscription relating to Kamose, the last King

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[26] Badawy, “Architectural provision against heat in the Orient” (1958).

of the Theban Seventeenth Dynasty.[27] The term is *šrwt*, which he renders in context as the "*narines au-dessus de leurs murs*" / "the openings / nostrils / wind-catchers at the top of their walls", enabling a translation:

> "(Kamose relates:) I saw (Apopi's) wives on the roof of his dwelling spying through their windows toward the quay. Without moving any more after they saw me, they looked through their wind-catchers (*šrwt*) at the top of their dwellings, like little *ỉnhw* in their holes, saying: "That was quick!"."

In 2016, three scholars Armando Di Nardo, Adriana Rossi and Luis Palmero, published a new interpretation of the evidence from Ancient Egypt, using a house-ground-plan on papyrus found in Oxyrhynchus (modern El-Bahnasa) from the 2nd century B.C.E. They also draw upon all other evidence known to them from Ancient Egypt.[28]

The importance of these recent publications cannot be underestimated because whilst very few people are interested in medieval Egyptian history, everybody claims an interest in Ancient Egypt. More on that theme below. See also the contributions of Robert W. Daniel referred to in **Ch. 10**.

Alexandre Lézine

It was not until the publication in 1971 of a seminal paper by the French architect and archaeologist of Russian origin, former director of the Service des monuments historiques in Tunisia, Alexandre Lézine (1906-1972), that the Cairo wind-catchers started to gain limited attention. His study was entitled "La protection contre la chaleur dans l'architecture

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[27] Monnier, "Les narines au-dessus de leur murs" (2013). This reference was kindly communicated to me by Olivier Jaubert from (*ʿan*) his friend the Egyptologist Marc Gabolde.

[28] Di Nardo & Rossi & Palmero, "From the redrawing of the papyri to the paradigms of passive ventilation in architecture" (2016).

musulmane d’Égypte” / “Protection from heat in the Muslim architecture of Egypt”.[29] Lézine discussed examples of cooling-devices from all over the Islamic world, and his study should be the starting-point for any more detailed regional studies. In spite of the title of his study pointing to Egypt, he actually devoted just a few pages to the Cairo *malqaf*s, as he called them, and we shall return to his work again below. It must be stated, however, that not only did he present a list of a dozen or so wind-catchers that he had personally inspected, but also he pointed to references to these devices in medieval Islamic geographical literature and medieval European travellers’ reports. In this way he set the scene for further research.

Lézine was writing his paper about the same time I was finding manuscript copies of a curious astronomical table for orienting a wind-catcher. Olivier Jaubert – see below – was working entirely within this same French tradition when in 1995 he documented all known wind-catchers in Cairo.

The most wretched one (العبد المسكين)

My doctoral thesis (1972) dealt with the works of the Fatimid astronomer Ibn Yūnus (d. 1009), the leading astronomer of medieval Egypt and one of the most significant astronomers of Islamic civilization.[30] In 1973, still fresh from graduate school and newly installed for further research in Cairo, I published the first description of the Cairo corpus of some 200 pages of tables for astronomical timekeeping and regulating the times of prayer, attributed in numerous manuscripts to Ibn Yūnus.[31] This corpus of tables was not previously known to exist, but it survives in many copies

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[29] Lézine, “La protection contre la chaleur dans l’architecture musulmane d’Égypte” (1971).

[30] King, *The astronomical works of Ibn Yūnus* (1972).

[31] King, “Ibn Yūnus’ *Very Useful Tables* for reckoning time by the sun” (1973). A more detailed account of the Cairo corpus is in *In Synchrony with the Heavens*, vol. I (2004): 247-358, with more detailed consideration of the authorship.

which nobody had ever looked at before in modern times. It was used in Cairo from the 10th to the 19th century.

One of these tables, in fact, the most curious, was for orienting a wind-catcher in a very special way.[32] Now why would a wind-catcher be oriented in an astronomically-defined direction on the local horizon, namely, winter sunrise?

The ʿIrāqī scholar ʿAbd al-Laṭīf al-Baghdādī who visited Cairo about 1200 had written that he had seen wind-catchers on most of the houses in Cairo, so obviously there was more that could be done. But I was young at the time and had no idea why the *bādahanj*es should be aligned in this way, to the extent that even some of my friends and closest colleagues could not fathom what I was talking about – see Len Berggren below (**Ch. 10**). Only in 2004 was I able to present a sensible account of the significance of the table, when I considered the Cairo corpus afresh in the light of all other known Islamic tables for timekeeping.

Franz Rosenthal

> "(The task of the orientalist) is to look beyond the culture in which one is rooted to other cultures what ever their geographical location with respect to Europe, in order to learn about and understand them and to try to spread the knowledge thus acquired." Franz Rosenthal, cited in Hans-Hinrich Biesterfeldt, ed., "Franz Rosenthal's Half a bibliography" (2014), pp. 34 & 36.

In 1977 Franz Rosenthal (1914-2003), one of the leading Western scholars of Classical Islamic thought in the 20th century, authored in 1977 a study entitled "Poetry and architecture: the *bādhanj*".[33] In this my former teacher at Yale University discussed the aesthetic and even erotic features of

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[32] King, "Ibn Yūnus' *Very Useful Tables*" (1973), esp. pp. 371-373, and *Synchrony*, vol. 1 (2004), pp. 270-271.

[33] Rosenthal, "Poetry and architecture: the *bādhanj*" (1977).

Cairene wind-catchers mentioned in a medieval anthology of Egyptian poetry from Fatimid, Ayyubid and Mamluk times, roughly, 11th to 14th century. These poems, collected in an anthology by the 14th-century Cairene scholar al-Ghuzūlī, had never been studied before. Rosenthal mentioned that his former student had shown that Ibn Yūnus had been involved with the theory of the construction and orientation of the wind-catchers already in the 10th century, and he showed that in later centuries these devices achieved a "modest amount of literary celebrity".

Franz Rosenthal's study has been overlooked even by those scholars who have written on Mamluk architecture in Mamluk textual sources! It has been cited by various Iranian scholars who are as fond of poetry as they are of wind-towers; this may be a result of the fact that the useful summary article "Bādgīr" in the *Encyclopaedia of Islam* by the leading British orientalist C. Edmund Bosworth mentioned Rosenthal's paper (and Ibn Yūnus).[34] Also, as we shall see, his study has been cited by S. D. Goitein, Geert Jan van Gelder, and Alev Masarwa.

The most wretched one once again (العبد المسكين كمان مرة)

In 1984, ever curious about the table for orienting a wind-catcher and further inspired by Franz Rosenthal's interest in the subject, I published a paper entitled "Architecture and astronomy: The ventilators of medieval Cairo and their secrets" in the *Festschrift* dedicated to my former teacher.[35]

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34 Bosworth, article "Bādgīr" in *Enc. Islam*, 2nd edn., supplement volume, XII, p. 115, with several references, also the same author's article "Sardāb (underground water reservoir)", *ibid*., IX, p. 49.

35 King, "Architecture and astronomy: The ventilators of medieval Cairo and their secrets" (1984), repr. with modifications in *idem*, *In Synchrony with the Heavens* vol. 1 (2004), VIIb: 773-823.

Summaries are in "Some illustrations in Islamic scientific manuscripts and their secrets" (1995), pp. 168-170, and "Aspects of Fatimid astronomy: From hard-

The study was based mainly on medieval Egyptian manuscripts dealing with astronomy and folk astronomy which specifically mention the *bādahanj*. These texts were not previously known to exist and they revealed much new information about the wind-catchers but also they showed that these devices provide the key to a new understanding of the city layout.

This study has also been overlooked ever since by virtually all scholars who have written on Fatimid and Mamluk Cairo, especially the city layout. Two scholars who had seen the paper claimed that I had established that the wind-catchers faced the *qibla*.

Olivier Jaubert

In 1995 Olivier Jaubert, a professional architect who as a student and thereafter was and is interested in the history of architecture, but who was also trained in Arabic and Islamic Studies, published "Capteurs de vents d'Égypte – essai de typologie". In this splendid study he documented scientifically close to 70 wind-catchers from ancient Egypt, Coptic Egypt, as well as some 50 from Islamic Cairo, of which some 20-odd predate 1500.[36] Precious few of these survive to this day. Others were known to Jaubert from references to Creswell's tomes on medieval Cairene religious architecture and the volumes by a series of French scholars at the Institut Français d'Archéologie orientale in Cairo documenting the houses and palaces of medieval Cairo. Yet others were known to him from the uncapped vertical shafts that the wind-scoops once dominated, or from engravings in the *Description de l'Égypte.*

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core mathematical astronomy to architectural orientations in Cairo" (1999), pp. 509-513.

[36] Jaubert, "Capteurs de vents d'Égypte. Essai de typologie" (1995). His nos. 1-12 are from Ancient Egypt and from Christian Egypt, and his nos. 81-85 are 'modern' examples.

Jaubert was able to classify the wind-catchers carefully according to type. He tended to use the modern Classical Arabic term *milqaf* although he was aware that the Arabicized Persian word *bādhahanj* was used in earlier sources (10th-19th centuries). His study concludes with very useful map of medieval Cairo showing the locations of the wind-catchers he included in his survey. Most of these lie in a swathe of the city parallel to the axis of the Fatimid city between the Mosques of Ibn Ṭūlūn and al-Ḥākim.

Alas, Jaubert was unaware of the studies of Rosenthal and King, contending that

> "aucune étude spécifique ne leur a été consacrée" / "no other study has been specifically dedicated to them."

He had access to all the (other) necessary literature on Cairo architecture, not only Creswell but all of the contributions by French scholars on the palaces and houses of historical Cairo. To his article the reader must still turn for all of the important background literature in French. Along with various diagrams and plans, a single photo of a decorative part of a Cairene wind-catcher from the *sabīl-kuttāb* of Aḥmad Bāshā (#67) illustrates his work.[37] Olivier Jaubert's was no armchair study: he personally visited the majority of the sites he documented. On the other hand, he also had access to the best of libraries, in Cairo or Paris or both.

Orientalists can work from materials such as photocopies of manuscripts or books and articles they have gathered, and they do not have to work in libraries all the time. My 1973 study of the Cairo corpus of tables for timekeeping was written in Ain El Mraisseh in Beirut. Franz Rosenthal's 1977 study was written between Yale University Library in New Haven, Connecticut, and his home in nearby Hamden. My 1984 study was written in Greenwich Village, New York City. The main part of present study was written during the summer of 2019 in a farm-house in a village in Southern France.

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[37] Jaubert, "Capteurs de vents" (1995), #67 on p. 207, and p. 220, fig. 1.

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In 2004, when I published a new version of my 1984 paper, I bemoaned the fact that Jaubert had not known of Rosenthal and King, but also the fact that, without the intervention of a *nadīm* (special sort of colleague) in Frankfurt, Carl Ehrig-Eggert, I would not have known of Jaubert 1995.[38] The situation of the wind-catchers seems even worse now since the vast majority of those who write on the architecture of medieval Cairo are unaware of all these studies. This has had the unfortunate consequence that most environmental engineers who write on the use of wind energy, mainly Iranian scholars, are not aware of the situation in medieval Cairo and write exclusively about the better-known wind-catchers of Iran, Pakistan and the Gulf regions.

Colleagues in the history of Islamic architecture tend to refer to wind-towers as "vernacular" even though they featured on religious architecture as well. Yet Jaubert's list is full of references to mosques and madrasas and Sufi convents, as well to palaces and private houses. Virtually all who have written on Cairene architecture of any kind have overlooked the documentation of Creswell, and, more especially, Maury and his colleagues, as well as the studies of Rosenthal, King and Jaubert, who between them have documented a substantial number of both relevant medieval texts and modern architecture-historical sources, let alone, in the case of Jaubert, over 50 known *bādhahanj*es in Islamic Cairo.[39]

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[38] This assistance I am now free to acknowledge: compare King, *In Synchrony with the Heavens*, VIIb: 778.

[39] The field of Mamluk Studies has served us better. The *Mamluk Bibliography Online* lists all four. The 2012 *Bibliography of Art and Architecture in the Islamic World* by Susan Sinclair omits Rosenthal 1979. The *Mamluk history bibliography* of 1999 by Marc Mercier lists King 1984 and Jaubert 1995 but not Lézine 1971 or Rosenthal 1977.

As far as I aware, nobody has used the information provided by Jaubert about Ancient Egyptian and Coptic wind-catchers in order to pursue the origins of the medieval Egyptian tradition.

In brief, Jaubert's study has fallen mainly on deaf ears. But it just takes one person to bring it back into circulation – see below.

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In medieval times, the number of such devices was in the hundreds, if not thousands. How many houses there were in Fustat and Cairo at any time I will not venture to estimate. In the mid 11th century the Iranian scholar Nāṣir-i Khusraw – see **Ch. 4** – estimated the number of houses in Cairo at about 20,000, the number of shops at 20,000, with 30,000 people in the palace. Paulina Lewicka, in her important new book on food in medieval Cairene society, estimates that the population of Fustat at the height of its prosperity reached about 300,000, and that the population of Cairo reached about 450,000 before the plague of the 1340s.[40]

Three more recent studies

> " ... much aesthetic effort was displayed to present (the wind towers in medieval Cairo) with wit and rhetorical skill, because wind towers were, at least until the 19th century, an everyday architectural feature. However, the tradition of composing lines about wind towers ends in Arabic literature, presumably in the early 15th century, while in the Persian tradition it seems to have been continued." Alev Masarwa, "Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space" (2017), pp. 115-116.

[40] Lewicka, *Food and foodways of medieval Cairenes* (2011), p. 1, citing studies by Jean-Claude Garcin and André Raymond. See also Russel, "The population of medieval Egypt" (1966), based on cadastral and fiscal records over the centuries.

Lamees al-Dasouqi / Lamis El Dessouki

Until June, 2019, I was not aware that the information in Jaubert's study had been cited by any other scholar besides myself (in the 2004 version of my 1984 paper). It was then that I learned that an Egyptian student لميس الدسوقي, Lamees al-Dasouqi, had used it in 2014 for a Master's dissertation in Arabic on Mamluk and Ottoman window-catchers.[41] The author was not aware of Rosenthal 1977 and King 1984 but was clearly able to profit from the copious information in Jaubert 1995. I have not been able to consult her thesis, but later I shall present her summary of it. In May, 2020, as I was about to put this monograph online, I discovered the author on Facebook as Lamis El Dessouki, but even a message via Facebook went unanswered.

Hamdia Saleh Dilli

Another study in Arabic which came to my attention in November, 2019, is by حمدية صالح دلي , Hamdia Saleh Dilli, Assistant Professor at the College of Education at al-Qadisiya University in Iraq. This is entitled اجهزة التبريد في العصر العباسي (البادهنج انموذجا), "Cooling devices in the Abbasid Age (the wind-catcher as an example)" and it was published in the Humanities journal of the University of Kufa in 2017.[42]

The author provides an interesting overview of some of the sources for the history of the *bādahanj*, in the light of current interest in the environment. Her study is not limited to the situation in Abbasid al-ʿIrāq, for which there is very little source material anyway. Rather she embarks upon a survey of the whole Arab world (thereby excluding Iran and the modern developments in the Gulf) and jumps from one region and epoch to

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41 al-Dasouqi, *The Wind Catchers in the City of Cairo in the Mamluk and Ottoman periods* (in Arabic) (2014).

42 Hamdia Saleh Dilli, "Cooling devices in the Abbasid Age (the wind-catcher as an example)" (in Arabic) (2017).

another, without mentioning either region or century, and thereby tends to confuse what the sources tell us. The footnotes and bibliography provide a difficult guide to the sources cited, most of which are on the internet, but several of the page references are incorrect. Ibn Yūnus and the *qibla* and the "correct" orientation of a *bādahanj* – these are all mentioned in passing but no references are given, nor is it stated that they refer only to Cairo.

This notwithstanding, the author deserves much praise for embarking on the subject and realizing its importance. She presents quotes from the following sources: al-Tanūkhī, Ibn Faḍlallāh al-ʿUmarī, ʿAbd al-Laṭīf al-Baghdādī, Ibn Baṭṭūṭa, al-Khafājī, al-Rāzī, Ibn Sīnā, Ibn al-Nafīs (?), Ibn al-Rāmī (new to the scene), al-Shubrāwī, as well as various poets (from al-Ghuzūlī's anthology), Dozy's dictionary and Hassan Fathy. There is, alas, not a single diagram or illustration, nor any reference to the many illustrations on the internet. This is particularly unfortunate when we read things like:

> ويتكون البادهنج من برج هوائي تعلوه فوهة عليا مفتوحة من جميع جهاتها, "the *bādahanj* consists of an air-tower right at the top of which is an aperture (*fūha*) open on all of its sides" (p. 223),

this being true only for *bādgīr*s in Iran.

Alev Masarwa

In August, 2019, I stumbled upon a reference to a new monograph by Alev Masarwa in 2017 dealing with the *bādahanj* in medieval Egyptian poetry, this time in a second anthology by the well-known littérateur and poet Ibn Abī Ḥajala al-Tilimsānī.[43] Masarwa takes the study of the materials used in Rosenthal 1977 and found in this new anthology to new heights. She kindly provided me with a copy of her published paper, as well as references to several useful sources, and I shall refer to her study again

[43] Masarwa, "Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space" (2017).

several times below. However, I shall refrain from citing it extensively because I hope that Alev Masarwa will eventually publish a new study of all of the available poetry on the Cairo *bādahanj*es.

3 — Wind-catchers in early medieval texts (not Egypt)

> "The highest object of the study of history is to point out the oneness of mankind beyond and above all its differences in race, colour and religion." Credo of the Hungarian Jewish Orientalist Ignaz Goldziher (1850-1921), from the introduction to the English translation of *A Short History of Classical Arabic Literature,* (1908/1966), p. vii. (If there exists a better introduction to Arabic literature, I am unaware of it.)

> "Of making many books there is no end, and much study is wearisome to the flesh." *Ecclesiastes*, XII:12 // "Of making many books there was no end in medieval Islam." Part of the title of a paper by Franz Rosenthal, 1995.

> "One of the perpetual delights, as well as one of the continual hazards, of following wherever the books lead, is the fact that we are forever being dropped without warning into new topics where we are total innocents, and we must attempt to become Instant Experts … … . The repeated scramble to master a historical framework new to us is at the same time exhilarating and terrifying," Mary A. Rouse & Richard H. Rouse, *Authentic Witnesses: Approaches to medieval texts and manuscripts* (1991), p. 10, cited in King, *Ciphers of the Monks* (2001), p. 15. (Sentiments shared by this author.)

Before we turn to specifically Egyptian sources on the *bādahanj*, there are a few references from the central lands of Islam, mainly Iran, al-ʿIrāq and Syria, but also Anatolia and Tunis, that we should consider. These references alas cast little light on the situation in these regions. In the cases of Anatolia and Tunis, in spite of this textual evidence, we cannot be sure that there ever existed *bādahanj*es there. But later we shall discuss a ventilation scheme from 12th-century Sicily, namely, in a castle whose construction is said to be totally of Islamic inspiration, for which, as far as I know, nobody has ever hypothesized an origin.

References from Abbasid al-ʿIrāq and elsewhere

al-Masʿūdī

The well-known scholar al-Masʿūdī (*ca*. 890 - 956) was born in Baghdad and spent from 941 until his death in Egypt.[44] He was a prolific writer on things historical and geographical and much more besides. His best known work is his enormous مروج الذهب ومعادن الجوهر, *Murūj al-dhahab wa-maʿādin al-jawhar*, "Fields of Gold and Mines of Jewels", completed in 946/47 and based on over 150 sources. (The title refers to the author's creating a necklace from strewn gold and jewels.) The work deals *inter alia* with the Abbasid caliphs.[45]

al-Masʿūdī provides the first attestation known to us. The year is 332 Hijra (943/44), but the reference relates to the death of the Caliph al-Muntaṣir (*reg*. 861-862) in 248 H (862), and al-Masʿūdī's source for that story clearly mentions a *bādahanj*.[46] Intrigues take place during a period of anarchy in the Abbasid government. al-Mustanṣir is caliph for only six months. There is war with the Byzantines and there are problems with the Turkish soldiery which had led to the death of his father, al-Mutawakkil. The scene is the new capital of Samarra or the nearby palace of al-Jaʿfariyya.

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44 See the article "al-Masʿūdī" in *Enc. Islam*, 2nd edn., by the French orientalist Charles Pellat (1914-1992), who is the author of a new French translation, *Les prairies d'or* (1979), to replace that of 1861-1877 by the orientalists Barbier de Meynard and Pavet de Courteille. See also the article "al-Masʿūdī" by Michael Cooperson in *Essays in Arabic Literary Biography*, I, pp. 234ff.

45 For the context see the articles "al-Mutawakkil ʿalā 'llāh" by the British Arabist and historian Hugh Kennedy, and "al-Muntaṣir" by C. Edmund Bosworth in *Enc. Islam*, 2nd edn., also "Sāmarrā'" by the Paris-based British archaeologist and art historian Alastair Northedge.

46 al-Masʿūdī, *Murūj al-dhahab*, text & French transl. by Barbier de Meynard and Pavet de Courteille, VII, pp. 297-299. (Not in the *Kitāb al-Tanbīh wa 'l-ishrāf*.)

For our purposes the dream recorded in the story is more important than the context of the story. al-Masʿūdī relates:

> ... واخبرت عن ابي العباس احمد بن محمد بن موسى بن الفرات قال كان احمد بن الخصيب سيء الرأي في والدي وكان عاملا له فجاءني مخبر من خدم الخاصة فقال ان الوزير قد ندب لاعمالكم فلانا وقد امره في والدك بكل مكروه وان يصادره على جملة من المال غليظة ذكرها فقعدت وعندي بعض اصدقائنا من الكتاب ابادر بالكتاب الى والدي بذلك فاشتغلت عن جليسي الكاتب فاتكا على الوسادة وغفي فانتبه مرعوبا وقال اني قد رأيت رؤيا عجيبة رأيت احمد ابن الخصيب واقعا في هذا الموضع وهو يقول لي يموت الخليفة المنتصر الى ثلثة ايام قال فقلت له الخليفة في الميدان يلعب بالصولجان وهذه الرؤيا ضرب من البلغم والمرار وقد قدمنا الطعام فما استتمنا الكلام حتى دخل علينا داخل فقال رأيت الوزير في دار الخاصة غير مسفر الوجه واني سألت عن سبب ذلك فقيل لي ان الخليفة المنتصر انصرف من الميدان وهو عرق فدخل الحمام ونام في الباذهنج فضربه الهواء فركبته حمى هائلة فدخل عليه احمد بن الخصيب فقال له يا سيدي انت متفلسف وحكيم الزمان تنزل من الركوب تعبا فتدخل الحمام ثم تخرج عرقا وتنام في الباذهنج فقال له المنتصر اتخاف ان اموت رأيت في المنام البارحة آتيا اتاني فقال لي تعيش خمسا وعشرين سنة فعلمت ان ذلك بشارة في المستقبل من عمري واني ابقى في الخلافة هذه المدة قال فمات في اليوم الثالث فنظروا فاذا هو قد استوفى خمسا وعشرين سنة ...

> "I was informed by Abu 'l-ʿAbbās ibn Muḥammad ibn Mūsà ibn al-Furāt the following. He said: Aḥmad ibn al-Khaṣīb did not look favourably upon my father (Muḥammad), who was a governor / agent of his. Someone who was attached to the interior service of the palace came to me and told me that the minister had appointed a certain (unnamed) person in the areas of our jurisdiction and had ordered him to crack down on my father in all sorts of nasty ways and to extort from him a considerable sum, which he specified. I sat down and with me were some of our friends from amongst the scribes were with me. It occurred to me to send a letter to my father about these matters (concerning the Turkish conspiracy mentioned above) and so I neglected my friend the scribe who was sitting next to me and he leaned down on the cushions and dozed off, and then woke up terrified.
>
> "He said to me: I had a strange vision. I saw (the *wazīr*) Aḥmad ibn al-Khaṣīb standing here and saying: The Caliph will die in three days' time. So I said to him: The Caliph is on the pitch playing polo and this vision is a kind of spittle and bile (*i.e.*, nonsense).
>
> "Food arrived and we had not finished this conversation when someone came in and said: I saw the vizier come into the private residences looking

very unhappy. I asked him the reason for this and I was told the Caliph al-Muntaṣir had left the pitch sweating and had gone to the *ḥammām* and then went to sleep in the ***bādahanj***. The wind beat down upon him and he ended up with a terrible fever. Aḥmad ibn al-Khaṣīb came into his residence and said to him: Sir, you are the Philosopher and Savant of the Age, and here you get off you horse exhausted, you go into the *ḥammām*, then you come out sweating and you sleep in the ***bādhahanj***!

"al-Muntaṣir replied: Are you afraid that I should die? Last night I saw in my sleep someone came to me and said to me: You will live for twenty-five years. So I knew this was a good prophesy for the future of my life. I shall remain as Caliph for that length of time! (Abu 'l-ʿAbbās) said: (The Caliph) died on the third day. They checked and – lo and behold – he had completed twenty-five years (since his birth)."

al-Tanūkhī

The *littérateur* and anecdotist Abū ʿAlī al-Muḥassin ibn ʿAlī al-Tanūkhī (941-994), born in Basra but later working in Baghdad, was the author of *al-Faraj baʿd al-shidda*, a work in the genre of "escape from hardship".[47] All the stories were cases of deliverance from some danger or misfortune that seemed hopeless; in most cases the *Qur'ān* or the Prophet played a role. al-Tanūkhī related a story which allegedly took place under the Caliph al-Muqtadir (*reg*. 908-932) and mentions a *bādahanj* in his

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[47] See the article "al-Tanūkhī" in *Enc. Islam,* 2nd edn., by H. Fähndrich. See below on the first of four projected volumes of an English translation.

harem.[48] [49] [50] The story revolves around a judge named Abū ʿUmar, who knew some of the cleaners in the Caliph's harem. I dare say that this story is of a kind unique in the Arabic literary sources, so since the story revolves around a *bādahanj* and since I have not found a serious translation anywhere, I present an almost complete translation here.[51] I

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[48] al-Tanūkhī, *al-Faraj baʿd al-shidda*. I have used a version on the internet (www.islamicbook.ws/amma/alfrj-.pdf) which has no indication of editor or date and no page-numbers, but at least it has a search function. The original text was edited by the Iraqi scholar ʿAbbūd al-Shaljī in 1978, in which our passage occurs on II, pp. 137-139.

[49] On the general situation of concubines at caliphal courts see the book by the 13th-century ʿIrāqī historian Ibn al-Sāʿī (article in *Enc. Islam*, 2nd edn., by Franz Rosenthal), now available as Toorawa *et al*., *Ibn al-Sāʿī: Consorts of the Caliphs – Women and the court of Baghdad* (2015). Earlier 19th- and 20th-century works are listed in the bibliography of the short article "Ḥarīm (harem)" in *Enc. Islam*, 2nd edn., written by the editors of the *Encyclopaedia*, and the other articles mentioned there.

On the situation under al-Muqtadir see van Berkel, "The young Caliph and his wicked advisors: Women and power politics under Caliph al-Muqtadir" (2007); and El Cheikh, "Women's History: A Study of al-Tanukhi" (2002) & "Gender and Politics: The Harem of al-Muqtadir" (2004).

[50] I am not aware of any previous translation of this text, but there must be several. Hamdia Dilli ("Cooling devices in the Abbasid Age (the wind-catcher as an example)" (in Arabic) (2017), pp. 224-225) presents a synopsis of part of the text, citing as source a mysterious title *al-Bad' wa-'l-ta'rīkh*, p. 132. Nadia Maria El Cheikh ("Revisiting the Abbasid harems" (2005), p. 8, also "An Abbasid Caliphal family" (2013), pp. 330-331, and "The Harem (of al-Muqtadir)" (2013)) presents a short but inaccurate summary, extracted below, without mentioning the judge or the *bādahanj*, or the repentance of the judge, and skimming over the "amorous behaviour" of the Caliph (which has also been ignored by other commentators).

[51] Alas, the new edition and English translation by the British scholar of Oriental Studies Julia Bray of the first three chapters of *al-Faraj baʿda 'l-shidda* does not cover this episode. It does, however, give great insight into the nature of the stories related by al-Tanūkhī. See Bray, *Stories of Piety and Prayer: Deliverance follows*

cannot claim to fully understand the introduction to the story, but it does not refer to the *bādahanj*, so I have omitted it.

The reader should be forewarned that al-Muqtadir was a profligate type, son of a Byzantine slave-woman who herself wielded considerable influence in Baghdad. He is said to have had several thousand female slaves and concubines, which would in part account for his eventual demise. The story concerns the judge Abū ʿUmar and how he went grey in one night whilst stuck in the *bādahanj* in the Caliph's harem. Amongst other things, it shows that the *bādahanj* was very much a feature of Baghdad architecture at the time, a fact not generally known.

We shall encounter a *bādahanj* with a curtain in front of it that is sprinkled with water by servants. For the material of the curtain al-Tanūkhī uses Arabic خيش, *khaysh*, for which I use the word "burlap", even though it is a relatively late word in the English vocabulary (from the Dutch for "farmer's cloth"), rather than "sackcloth", which has somewhat negative connotations ("sackcloth and ashes" for serious penitents). Even though I live mainly in the German State of Hesse, I shall not use the alternative word "hessian", which will be foreign to most readers anyway. There are dozens of names in English for coarse cloth.[52] What I mean is a very coarse, rough fabric woven from flax or hemp, similar to, but heavier than the cloth now used to make sacks for potatoes and the like, which is essentially porous enough to let air pass through once it has absorbed moisture, but thick enough to hold water and also to need refreshing by a sort of combing action once in a while. The material should be sufficiently heavy, especially when sprinkled with water, to hang straight down. In other words, it should not be a light mesh or thin gauze so that it simply rises up and flaps when the wind blows out of the *bādahanj*. This is only Arabic text I have come across that gives such details, although the

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Adversity (2019), and also https://arablit.org/2019/05/30/julia-bray-on-translating-al-tanukhi-a-useful-thinker-for-our-times/.

52 See phrontistery.info/fabric.html.

Frenchman Jean Coppin, writing in the 17th century, does mention such a curtain at the bottom of a ventilation-shaft.[53]

The Arabic reads as follows. Parts underlined are the elucidations of a commentator. The asterisk refers to a minor error in the published text.

فبلغت النوبة الي في يوم كنت فيه مخمورا فدخلت ومعي رجالي الى دار فلانة وذكر حظية جليلة من
حظايا المقتدر بالله لرش الخيش فلعظم ما كنت فيه من الخمار ما رششت قربتي ولم اخرج بخروج الرجال
وقلت لهم امضوا فهاتوا قربكم لاتمام الرش فاذ رششتموها فانبهوني فاني نائم هنا ودخلت خلف الخيش
الى باب بادهنج تخرج منه ريح طيبة فنمت وغلب علي النوم الى ان جاء الفراشون وفرغوا من رش
الخيش وخرجوا ولم ينبهوني وتمادى بي النوم فما انتبهت الا بحركة في الخيش فقمت فاذا انا قد امسيت
واذا صوت نساء في الخيش فعلمت اني مقتول ان احس بي وتحيرت فلم ادر ما اعمل فدخلت البادهنج
وكان ضيقا فجعلت رجلي على حائطي البادهنج وتسلقت فيه ووقفت معلقا اترقب ان يفطن لي فاقتل واذا
بنسوة فراشات يكنسن الخيش فلما فرغن من ذلك فرشنه وعبي فيه مجلس الشراب ولم يكن باسرع من
ان جاء المقتدر بالله وعدة جواري فجلس وجلسن واخذ الجواري في الغناء وانا اسمع ذلك كله وروحي
تكاد تخرج فاذا اعييت نزلت وجلست في ارض البادهنج فاذا استرحت وخفت ان يفطن بي عدت فتسلقت
الى ان مضت قطعة من الليل ثم عن للمقتدر ان يجذب* اليه حظيته التي هي صاحبة تلك الدار فانصرف
باقي الجواري وخلا الموضع فواقع المقتدر بالله الجارية وانا اسمع حركتهما وكلامهما ثم ناما في مكانهما
ولا سبيل لي الى النوم لحظة واحدة لما اقاسني من الخوف ففكرت في ان اخرج واصعد الى بعض
السطوح ثم علمت اني ان فعلت ذلك تعجلت القتل ولم يجز ان انجو فلم تزل حالي تلك الى ان انتبه المقتدر
بالله في السحر وخرج من الموضع فلما كان من غد نصف النهار جاء عريف آخر من الفراشين ومعه
رجاله فرشوا الخيش فخرجت فاختلطت بهم فقالوا ايش تعمل هاهنا؟ فاومأت اليهم بالسكوت وقلت الله الله
في دمي فان حديثي طويل فتذمموا ان يفضحوني وقال بعضهم ما بال لحيتك قد شابت فقلت لا اعلم
واخذت ماء من قربة بعضهم فرطبت به قربتي وخرجت بخروجهم فلما صرت في موضع من دار الخليفة
وقعت مغشيا علي وركبتني حمى عظيمة وذهب عقلي فحملني الفراشون الى منزلي وانا لا اعقل فاقمت
مبرسما مدة طويلة وقد كنت عاهدت الله تعالى وانا في البادهنج ان هو خلصني ان لا اخدم احدا ابدا ولا
اشرب النبيذ واقلعت عن اشياء تبت منها فلما تفضل الله تعالى بالعافية وفيت بالنذر وبعت اشياء كانت لي
وضممتها الى دراهم كانت عندي ولزمت دكانا لحميي اتعلم فيه التجارة معه واتجر وتركت الدار فما
عدت اليها الى الآن ولا اعود ابدا الى خدمة الناس ولا انقض ما تبت منه قال ورأيت لحيته وقد كثر فيها
الشيب

"Disaster struck me one day when I was drunk. I entered together with my men into the house of a certain lady (*fulāna*) – (the commentator) mentioned that she was an important concubine (جارية, *jāriya*, lit. slave-girl) of (the Caliph) al-Muqtadir bi-llāh – to water the burlap, and because of the seriousness of my drunken state, I did not even fill my own pouch

53 See n. 160 below for another mention of a curtain.

with water. And I did not leave when my men left, saying to them: "Off you go, and bring your water-sacks to complete the watering when you return, and when you have finished watering, then wake me up because I shall be sleeping here." Then I went behind the burlap to the entrance of the ***bādahanj***, from which there was emerging a favourable breeze, and I fell asleep. I was in a deep sleep until the cleaners returned and finished with wetting the burlap. They left and did not (even) wake me.

Then there came the sound of the voices of women in the company of (the Caliph) al-Muqtadir who had come in(to the house). And I knew that if anyone realized I was there, then I was (as good as) dead. I became perplexed and did not know what to do. So I went inside the ***bādahanj*** and put my two legs on the two walls of the ***bādahanj*** and climbed up inside it, and when I stopped I was just hanging there, expecting that I would be noticed and that I would be killed. Then there appeared some women-servants to sweep the burlap and when they had finished that they furnished (the place) and prepared it for a drinking session. And that was just soon enough because al-Muqtadir came in with a number of concubines. He sat down and they sat down; and the concubines started to sing. Now I could hear all of this and my soul almost left my body, and I became sick so I came down and sat of the floor of the ***bādahanj***. Thus I was able to relax a bit, but I was still afraid that I would be noticed, so I climbed up again (inside the ***bādahanj***), remaining up there until part of the night had passed. Then al-Muqtadir got into his mind to have his concubine, the owner of the house, come closer to him, so the rest of the concubines went off and left the place. Then al-Muqtadir had intercourse with the concubine and I could hear the movements and the talking of the two of them, and then they both fell asleep right in that same place. Now because my fear had become so bad, there was no way for me to sleep for a single moment. So I thought I might get out by climbing up (the inside of the ***bādahanj***) onto one / some of the roofs, but I realized that if I did this I would bring on my own death even more quickly. It was not possible that I escape. So I remained like this until al-Muqtadir woke up in the early morning and left the place. In the late morning (*g̲had*), shortly before midday, there came another head-cleaner with some men and they furnished the burlap, and it was then that I came out and joined them, and they asked: "What are you doing here?" and I beckoned to them to be silent, and I said: "(Oh) God! (I fear) God with regard to my life!"** Then

one of them asked: “What’s wrong with your beard that it became grey?” I replied: “I don’t know.” I took water from the water-pouch of one of them and wetted my own pouch, and I went out when they did. When I reached a (certain) place in the Palace of the Caliph, I fell unconscious and I was overtaken by a high fever and my mind went, and the servants carried me to my own house. I was not able to think straight and I remained (as if) afflicted with pleurisy and delirium (مبرسم, *mubarsam*) for a long time.

Whilst I had been in the ***bādahanj*** I had made a vow to God Almighty that if He delivered me, I would never serve anyone (but Him), and I would (never again) drink wine, and in future I would desist from all those deeds for which I had repented. When God Almighty graciously brought me back to good health, I fulfilled my vow and I sold things that I had added them to the money I had, [in order to give it all away];*** I stayed in a shop which my father-in-law had so that I could learn commerce with him and work as a merchant (in the shop); I abandoned the Palace and never went back to it up to now; I never returned to public service; and I shall not break my vow of repentance. (The commentator) said: “I saw his beard and it had become really grey.”

* text: جذب, ** الله الله في دمي, literally, God, God in my blood, for اتقي الله في دمي, I fear God with regard to my life, that is, I fear God will take my life. *** not in the Arabic, but seems a reasonable restoration

So the entrance to the air-shaft of the *bādahanj* was large enough to have a floor (ارض, *arḍ*) on which someone could sit. In front of the opening there hung a curtain of خيش, *khaysh*, or burlap (as opposed to a regular cloth) which was such that moist air could come through it. Wetting the burlap at the bottom of the air-shaft in the *bādahanj* was clearly a well-established custom, and it would occasionally have to be “swept” (كنس, *kanasa*, to sweep) to disentangle and unlock the matted fronds that might be clumped together. al-Tanūkhī’s text is the only known medieval one mentioning a *bādahanj* which mentions this sort of activity. (Hassan Fathy seems to have revived the tradition of putting damp charcoal beneath his wind-holes.) It is, however, well documented that wetting the streets in the city and the floors in the court-yards in Cairo was a well-established custom. Amalia Levanoni, a leading historian of the Near East who has specialized on the Mamluks, in her study of water supply in medieval

Cairo records that the Maghribī traveller Ibn Baṭṭūṭa, who visited Cairo *ca*. 1325, reported that Cairo had 12,000 water vendors (*saqqāʿūn*) and 30,000 street waterers (*makkārūn*).[54] The German traveller Johann Wild who was in Cairo during 1606-1610 mentioned that since the city of Cairo was not paved and the streets were nothing but mud and earth, in summer cameleers would bring Nile water in goatskin bags (*outres en cuir*) to wet the streets so that there would be no dust.[55]

Now our judge considered climbing up inside the *bādahanj* to escape onto the roof. This suggests that there must have been some sort of ladder inside the device. (A ladder is actually mentioned in the story involving a *bādahanj* from the *1001 Nights* later in **Ch. 4**.) Precisely how he was functioning for hours with one leg, that is, one foot, on each of the opposite walls of the *bādahanj* is not clear.

Whether there is any truth to the story we shall never know. Certainly, the story casts light on what al-Tanūkhī thought of the function of the *ḥarīm*. We should keep in mind that he wrote this story over a thousand years ago.

The moral of the story was firstly, that one should not drink and certainly not get blind drunk, and secondly, that as a normal mortal one should not enter the Caliph's harem, let alone hang around to get an eyeful of what might happen there.[56] But there was more. Doing both of these and then

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54 Levanoni, "Water supply in medieval Cairo" (2007), p. 182.

55 Johann Wild, *Voyages en Égypte 1606-1610*, 1973 edn., p. 176 (*ex* 317).

56 Nadia Maria El Cheikh, in her 2013 article on the harem of al-Muqtadir, presents a limited translation of the story:

> "Another source includes a yet more intimate description of al-Muqtadir's harem: it was the duty of palace attendants to occasionally enter the women's quarters (*dūr al-ḥuram*) in order to clean the sleeping areas. One of the attendants on duty entered the quarters of an important concubine of al-Muqtadir while he was drunk. The attendant fell asleep and was left behind while the other attendants evacuated the private quarters. He was awakened in the evening by the voices of women who came to clean up the quarters and set it up as a drinking *majlis*. Al-Muqtadir arrived with a number of slave girls who started singing. Al-Muqtadir then

being present, if only behind the burlap, whilst the Caliph and his concubine came together as one, was, of course, *un peu de trop*. It is small wonder that after all this, the judge had a breakdown which changed his life, but his repentance saved it, so he thought. And that – salvation through repentance – was the main point of al-Tanūkhī's tale, indeed, of all of his 40, I think I read somewhere, tales in *al-Faraj baʿda ʻl-shidda*, "liberation after hardship".

A reference to *bādahanj*es from 10th-century Basra

The Oxford-based English orientalist David Samuel Margoliouth (1858-1940) included the word *bādahanj* in a glossary appended to his translation of the Arabic commentary on the *Book of Daniel* by the 10th-century Karaite Jewish scholar Yephet ben Alī of Basra, later Jerusalem. The phrase:

> بعضها بيوت الصيف وهي بادهنجات, *baʿḍuhā buyūt al-ṣayf wa-hiya bādahanjāt*, some of (these houses) are summer-houses, which are *bādahanj*es, …"

is stated by Margoliouth to be from the commentary (of Yephet) on the *Book of Amos* (II:12).[57] That verse has no direct mention of houses, rather only 'Nazarites', wine and prophets. This left me somewhat bewildered because there is no evidence that the famous Karaite commentator (on the whole *Tenakh*) ever visited Cairo. A modern commentary in Hebrew on

chose the concubine 'who lived in these quarters' and the rest left. The attendant who remained in hiding witnessed the amorous behaviour of al-Muqtadir and his concubine."

57 Margoliouth, *Jephet ibn Ali: Commentary on the Book of Daniel* (1889), p. 89. The reference was included by Joshua Blau, the world-expert on Judaeo-Arabic, in his list of words mainly from Judaeo-Arabic, to supplement Dozy's Arabic-French dictionary: see Blau, "Additions to Dozy's *Supplément*" (1982), p. 115.

Yephet's commentary exists in an unpublished doctoral thesis, whence enlightenment might be forthcoming.[58]

The *Epistles* of the Brethren of Purity

The *Ikhwān al-ṣafā*, or "Brethren of Purity", were an esoteric fraternity of Ismāʿīlī Shīʿīs who seem to have been active in Basra in the second half of the 10th century. They compiled some 52 epistles (رسائل, *rasā'il*) in mathematics, natural sciences, psychology and theology. The following charming comparison of the human body with a house is taken from the excellent anthology of Arabic literature in translation by the Dutch orientalist Geert Jan van Gelder:[59]

> "The human body as a house. Know that this body stands in relation to this soul of ours as does a house to its inhabitant; a house that is well built, divided into rooms, its storerooms full, its roofs raised, its doors open, its curtains drawn, and equipped with everything that the owner of the house needs, such a beds, kitchenware, furniture, and other household goods, in the most perfect, the most complete and the most accomplished manner. Thus his feet, on which the body stands, are like the foundations of the house. His head, on the highest part of the torso, is like the loft. His back, behind him, is like the back of the house; his face, in front, is like the house's façade; his neck, with its length, is like the porch; the opening of his throat through which the voice moves is like the vestibule; the chest in the middle of his body is like the courtyard of the house; the cavities in his chest are like the rooms and storerooms in the house; his lungs and the coolness they provide are like the summer room; the nostrils, with the breath moving through the throat, are like the **ventilator shaft**; ... ."

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[58] Nadler-Akirav, *The Arabic commentary of Yefet Ben ʿAli on the Book of Amos* (2009).

[59] van Gelder, *Classical Arabic literature* (2012), pp. 220-221, also n. 603 on p. 393.

van Gelder's note to the last phrase reads "literally 'wind catcher' in Persian; also called *malqaf*", followed by a reference to Rosenthal's paper. I presume that the term used in the *Rasā'il* was *bādahanj*, but this should be checked, not least because this would be a very early attestation of the term, and not of Egyptian provenance.

Sibṭ al-ʿAjamī / Rāghib al-Ṭabbākh

The Aleppo historian Muḥammad Rāghib al-Ṭabbākh (1876-1950) in his monumental history of Aleppo related the following about the al-Sharafiyya Madrasa in that city, which was founded as a mosque before 1205 and most of whose building dates from two decades or more later:[60]

> المدرسة الشرفية الشافعية ... وهذه المدرسة بها ثلاثة ادوار من الخلاوي المحكمة البناء والابواب والخزائن وبها باعلى الايوان مع اعلى حاصلها المعروف الآن بالمغارة قاعة مليحة للمدرس ولهذه القاعة باب من الايوان وباب من ارض المدرسة وبصدر هذا الايوان بادهنج له ثلاثة ابواب ثم سد باب منها لاجل الزلزلة خوفا على الايوان ...

Part of this extract mentions:

> "an attractive reception room (*qāʿa*) for the teacher with one door opening on the main hall (*īwān*) and another opening onto the floor (?) of the *madrasa*. In the principal, inside wall of (*bi-ṣadr*) this main hall is a *bādahanj*, and it (that is, the main hall) has three doors, one of which had been closed off because of the earthquake for fear of the main hall (collapsing)."

Terry Allen in his detailed study of Ayyubid architecture in Syria quotes the source of this information, namely, the the Syrian historian Sibṭ al-ʿAjamī (1415-1480). He presents a slightly different translation of this passage:

> "Above the *īwān*-hall and the storeroom (*ḥāṣil*), now called "the cave" (*al-*

60 Rāghib al-Ṭabbākh, *Iʿlām al-nubalā' bi-ta'rikh Ḥalab al-shahbā'*, IV, pp. 425-426. Terry Allen's detailed study of this madrasa in his *Ayyubid architecture* at www.sonic.net/~tallen/palmtree/ayyarch/ch8.htm#alep.mshar.

maghārah), is an apartment (*qāʿah*) reserved for the professor, and in this apartment is a door (*bāb*) from the *īwān*-hall and one from the courtyard [? - *arḍ al-madrasah*] At the back (*ṣadr*) of this *īwān*-hall is an air shaft (*bādhanj*) in which were three openings (*abwāb*), until two of them were blocked for fear that an earthquake could damage the *īwān*-hall."

The earthquake in question is probably the one in 1408 that caused severe damage to Aleppo.[61]

al-Yūnīnī

Quṭb al-Dīn Abū 'l-Fatḥ Mūsà ibn Muḥammad al-Yūnīnī (1242-1326|) was a Syrian historian, whose major work ذيل مرآة الزمان, *Dhayl Mir'āt al-zamān* was a continuation (*dhayl*) of the universal history of Sibṭ Ibn al-Jawzī (d. 1256).[62] He mentions the following anecdote:

وجلس السراج الوراق في بادهنج ينظم فقال الجزار:

إن السراج نسيم الريح يوقظه ... إلى فوائد كالابريز ينتقد

يزيده الريح ايقادا لخاطره ... وما رأينا سراجاً في الهوى يقد

The story involves a certain al-Sarrāj, apparently a book-seller (*warrāq*) who sat in a *bādhahanj* and composed verses of poetry. A verse cited by one al-Jazzār cited involves a play on the name *al-Sarrāj*, "saddler", and

61 A detailed account of the effects of this earthquake is in Ambraseys & Melville, "Historical evidence of faulting in Eastern Anatolia and Northern Syria" (1995), esp. pp. 339-341. This is based on medieval Arabic texts cited by the British scholar of Persian history, Charles Melville, whose 1978 doctoral dissertation was on the historical seismicity of Iran.

62 See the article "al-Yūnīnī" in *Enc. Islam*, 2nd edn., including the complicated story of the text edition, by Jacqueline Sublet, and "Ibn al-Djawzī" by Claude Cahen. A more recent study of part of al-Yūnīnī's lengthy text is by Li Guo. For this story, kindly brought to my attention by Alev Masarwa, see al-Yūnīnī, *Dhayl Mir'āt al-zamān*, III, p. 22.

the word *al-sirāj*, "lamp", and the mention of the *bādhahanj* is not significant to the story.

Although al-Yūnīnī did visit Egypt three times, it appears at first sight that this a story which took place in Syria, probably Damascus, and this inevitably raises yet more issues.

Marco Polo visits Hormuz

The famous Venetian traveller Marco Polo (1254-1324) noted the wind-catchers of Hormuz on the Gulf:[63]

> "Hormos – a great and noble city on the sea. ... ... There are a good many cities and towns belonging to Hormos, and the people are Saracens. The heat is tremendous, and on that account their houses are built with ventilators to catch the wind. The ventilators are placed on the side from which the wind comes, and they bring the wind down into the house to cool it. But for this the heat would be unbearable."

A note by his translator, the Scottish orientalist Sir Henry Yule (1820-1889) adds (my emphasis):

> "These ventilators are a kind of masonry windsail, known as Bádgír, or "wind-catchers", and in general use over Oman, Kerman, the province of Baghdad, Mekran, and Sind. A large and elaborate example, from (Xavier) Hommaire de Hell's work on Persia, is given in the cut above. Very particular accounts of these ventilators will be found in Piero della Valle, and in the embassy of Don Garcías de Silva Figueros.[64] **A somewhat different arrangement for the same purpose is in use in Cairo, and gives a very peculiar character to the city when seen from a moderate**

[63] Henry Yule, ed., *The Book of Ser Marco Polo*, (1871), vol. II, pp. 450-451. I thank Eckhard Neubauer for sending me this text. See also www.imdb.com/title/tt3441072/.

[64] References as given: "*Della Val*. II 333-35; *Figueros*, Fr. Trans. 1667, p. 38; *Ramus*, I, 293 v.; *Macl. Kinnair*, p. 69".

height."

This last remark shows singular insight and is the only known written reference from the 19th century to wind-catchers/towers in both Iran and Egypt. I shall repeat this section below in the context of Egyptian wind-catchers.

Ibn Baṭṭūṭa

> Ian Richard Netton, "Ibn Baţţūţa in wanderland: voyage as text: was Ibn Baţţūţa an orientalist?" (2012). (Rarely does one encounter humour and irony in modern scholarly writings on Oriental Studies. This study was a pleasure to read.)

The celebrated Maghribī world-traveller Ibn Baṭṭūṭa (1304 - *ca*. 1370)[65] mentions the concept of the *bādahanj* in his account of his arrival in the small town of Birgi near Izmir, but this does not refer to a specific device of this kind. He writes, in the translation by the Scottish orientalist H. A. R. Gibb (1895-1971):[66]

> "a tent ... called ... *kharqa* consists of wooden laths put together in the shape of a cupola and covered with pieces of felt. The upper part of it can be opened to admit light and air, like a ventilation pipe (*bādhanj*), and can be closed when required."

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65 See the articles "Ibn Baṭṭūṭa" by André Miquel in *Enc. Islam*, 2nd. edn., and by Franz Rosenthal in *DSB*, also the article by Marina A. Tolmacheva in *Essays in Arabic Literary Biography*, II, pp. 126-137.

66 Rosenthal, "Poetry and architecture" (1977), p. 4, citing "Ibn Baṭṭūṭa, *Travels*, ed. trans. C. Defrémery and B. R. Sanguinetti, II, 299-300 (repr. Paris, n.d. [1969 ?]), transl. H. A. R. Gibb, II, 440 (Cambridge 1959)."

In the terminology of the present study, *bādahanj* means "wind-catcher", rather than "ventilation pipe". Now, curiously enough, the principal edition of Gibb's translation gives a slightly different rendering:[67]

> "When I arrived with the professor (Muhyí ad-Dín, the Sultan) sent his two sons to ask how we were, and sent me a tent of the kind they call *Khargáh*. It consists of wooden laths put together like a dome and covered with pieces of felt; the upper part is opened to admit the light and air and can be closed when required. ... ."

Here there is no mention of a 'ventilation pipe'. So we should go back to the Arabic, and there we find (my translation):[68]

> ... فلما بلغه خبر وصولنا بعث الينا ولديه خض بك وعمر بك فسلما على الفقيه وامرهم بالسلام علي ففعلا ذلك وسألاني عن حالي ومقدمي وانصرفا وبعث الي ببيت يسمى عندهم الخرقة (خرگاه) وهو عصى من الخشب تجمع شبه القبة وتجعل عليها اللبود ويفتح اعلاه لدخول الضؤ والرياح مثل البادهنج ويسد متى احتيج الى سده ...

> "When news reached (the Sultan of Birgi) of our arrival he sent his two sons Khiḍr Beg and ʿUmar Beg and they greeted (my companion) the legal scholar (Muḥyi al-Dīn) and he ordered them to greet me, which they did, and they enquired about my state and about the time of my arrival and then they went away. (The Sultan then) sent to me a place to stay (lit., house), which they call a *kharqa* (Turkish, *khargāh*). It is (made out of) strips of wood meeting in the form of a dome at the top, and on which they put pieces of felt. The top of this is open to allow light and wind to enter, like the ***bādahanj***, and this (orifice) can be closed when needed."

How fortunate we are to have editions of some important Arabic texts with translations *on the same page*, and these now available on the internet! Such is the 1853-59 edition of the orientalists Charles François Defrémery (1822-1883) and Beniamino Raffaello Sanguinetti (1811-1883), of the

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67 Gibb, transl., *Ibn Battúta – Travels in Asia and Africa 1325-1354*, 1929, I, p. 133.

68 Defrémery & Sanguinetti, eds. & transl., *Voyages d'Ibn Batoutah*, 1853-1859, II, pp. 299-300.

travelogue of Ibn Baṭṭūṭa, on which most later ‘editions’ and translations are based.

In 1326 Ibn Baṭṭūṭa visited Egypt where the *bādahanj* was common, and he visited Anatolia thereafter. The report on his travels was written after his return to Morocco, where no features similar to the Cairene wind-catchers are known to have been used. In short, this account has nothing to do with the wind-catchers of Cairo except for the use of the same name. On the other hand, we can be sure that there were wind-catchers of one sort or another in contemporaneous Anatolia. A recent study by Ayhan Bekleyen and Yahya Melikoğlu[69] reveals **all manner of different historical wind-catchers at least in the eastern regions of Anatolia**, where they are known locally as *badgel*-s. The kinds of tents that were used from Ukraine to Mongolia have been investigated by Peter Alford Andrews.[70]

Ibn al-Rāmī – a voice on urbanism from 14th-century Tunis

Nothing is known about the author of a remarkable book on compact urbanism except his name and the fact that he came from 14th-century Tunis. He was clearly a master-builder by profession. His work, entitled الاعلان باحكام البنيان, *al-Iʿlān bi-aḥkām al-bunyān*, *Revealing the laws of building construction*, seems to be unique of its genre.[71] He combined legal scholarship with practical experience as an expert witness under a number

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69 Bekleyen & Melikoğlu, “Antique wind catchers in Anatolia: Badgels of Şanlıurfa” (2019): at https://dergipark.org.tr/en/download/article-file/773636. This is a documented study with useful bibliography.)

70 Andrews, “From the Rashīdīya to the Ordos: In search of Early Mongol Tents” (2003).

71 Ibn al-Rāmī: *Rules for Compact Urbanism: Ibn al-Rami’s 14th Century Treatise*, edited by Besim S Hakim, transl. by Mohd Dani Muhamad, London: EmergentCity Press, 2017. (Earlier edition by Moh Abd al-Sattar Uthman, Alexandria 1409/1988.)

of *qāḍī*s (judges) in Tunis. The Arabic of his text has a rather modern ring about it, to the extent that one might think that this passage had been inserted by a modern commentator. But no, this is Ibn al-Rāmī. For a medieval author it is impressive not least for, and not alone for the use of the term التهوية, *al-tahwiya*, "ventilation". He writes:

> ان الباذهنجات هي عناصر التهوية انتشر استخدامها في العمائر الاسلامية وزادت الحاجة اليها في العمائر التي تحيط بها المباني من اكثر جهاتها وتفتقر واجهاتها المطلة على الطريق عن تزويدها بالهواء اللازم ولا سيما اذا كانت الوحدة التي تحتاج الى التهوية من الوحدات التي تزدحم غالبا بالافراد كقاعة استقبال في دار او ايوان للصلاة والاستماع الى دروس العلم في مسجد او مدرسة حيث يكون اللجوء الى الباذهنج لعدم امكان عمل نوافذ لهذه الوحدات في تلك المنشآت لغرض التهوية بسبب مجاورة المباني الاخرى وتجنب فتح نوافذ من شأنها التسبب في ضرر الكشف
>
> "***Bāḏhahanj*es** are elements of ventilation whose use spread in Islamic buildings. The need for them increased in buildings surrounded on most of their sides by other buildings and whose façades looking over the street are poorly equipped to provide them with the necessary air especially if the building unit that needs ventilation is one of the units in which individuals mainly crowd together, such as the reception hall in a (private) house, or in a mosque or madrasa the hall (*īwān*) for prayer or for listening to lessons for (acquiring) knowledge. In this case (people) will seek refuge to the ***bāḏhahanj*** because of the impossibility of inserting windows for such units in those constructions for the purpose of **ventilation** because of the proximity of those other buildings and avoiding opening windows on account of ... ... [meaning unclear to me]."

One may well wonder where Ibn al-Rāmī learned of the *bādahanj*. One should beware of assuming that the *bādhahanj* was known in Tunis and nearby cities. I know of no other references to *bādhahanj*es in Tunisian sources.

(It is not generally known that there was a vibrant astronomical tradition in medieval Tunis.[72] First, there was already some activity in the 10th

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[72] For an overview dealing with planetary astronomy, spherical astronomy and instrumentation see King, "On the history of astronomy in the medieval Maghrib"

century with the renowned astrologer Ibn Abī ʻl-Rijāl, who also prepared a set of astronomical tables (*zīj*). Second, the leading astronomer in the medieval Maghrib was Ibn Isḥāq al-Tūnisī (*fl. ca.* 1193 - 1222), already recognized as such by the great historian Ibn Khaldūn (1332-1406), and his major work, a *zīj* long deemed lost, was rediscovered in 1978 in a manuscript preserved in Hyderabad (Deccan). It is of such magnitude – 400 pages with 360 tables! – that it has kept historians of Islamic astronomy in Barcelona busy ever since.[73] The work of Ibn Isḥāq was influential in the Maghrib but also in medieval Europe, the solar, lunar and planetary parameters in it having been adopted in the Parisian *Alfonsine Tables*.[74] Third, there was substantial activity in astronomical timekeeping in Tunis during the 14th and 15th centuries, inspired by the tradition in 14th-century Damascus.[75])

The Zisa Palace in Palermo

(2007). On tables for timekeeping for Tunis see *idem*, *In Synchrony with the Heavens*, vol. 1 (2004), II: 427-436. On instrumentation in particular see *idem*, "Spherical astrolabes in circulation – From Baghdad to Toledo and to Tunis & Istanbul" (2018), section 3 on Tunis.

73 See the article "Ibn Isḥāq" in *BEA* by Julio Samsó, mentioning such ground-breaking publications as Àngel Mestres, "Maghribī astronomy in the 13th Century: A description of manuscript Hyderabad Andra Pradesh State Library 298" (1996), and the same author's doctoral thesis "Materials andalusins en *el Zīj* d'Ibn Isḥāq al-Tūnisī" (1999).

74 Samsó, "Ibn Isḥāq and the Alphonsine Tables" (2019), presents the latest discovery, namely, that astronomical tables in the tradition of Ibn Isḥāq were available to the astronomers of King Alfonso X (reg. 1252-1284), who used them both in their own astronomical works written in Castilian and also for the production of the Parisian *Alfonsine Tables*, extant only in Latin.

75 On timekeeping in medieval Tunis see King, *In Synchrony with the Heavens*, vol. 1 (2004), II: 427-436.

The Zisa Palace in Palermo is a Norman palace completely in Arab style, which dates from the period 1164-1175. My friend Carol Faenzi kindly drew my attention to its natural cooling system, which has been described as follows:[76]

> "On the ground floor, a hallway runs the entire length of the building and gives access to the Fountain Hall. This space is two storeys high and is conceived as an *īwān* with ornamental recesses built into the walls and decorated with *muqarnas.* A system of openings through the internal walls and of ventilation pipes fitted into the small towers at the sides gave a continuous circulation of air, which guaranteed a pleasant internal temperature even in extreme heat."

More details are given in a report on the ventilation system prepared by the Youth Committee of the Italian National Commission for UNESCO.[77] **Our young authors assume that the ventilation system is Arab, no questions asked. But, in fact, we do not know of any Arab ventilation-systems of this kind from that time (or earlier or later). Yet the inspiration <u>must</u> be Arab because the Northern Europeans were perhaps not so advanced at the time and in northern climes there is no need for such ventilation-systems. Also, the inside of the Palace is decorated with the multi-layer honey-comb design known in Arabic as *muqarnas*, which is purely Islamic.** Our young authors write:

> "The natural ventilation inside the castle was achieved through five main elements: the large pool in the garden at the front, the fountain located on the ground floor, the two ventilating chimneys and large wet sheets hung beneath the ceilings of the various rooms on the upper floors. ... ... The remaining hot air was refrigerated using wet sheets hung beneath the

76 Anonymous, "The Zisa of Palermo", n.d., at www.qantara-med.org/pu—*—blic/show_document.php?do_id=1164&lang=en.

77 Youth Committee of the Italian National Commission for UNESCO, "Air conditioning in the Middle Ages – How ancient architecture design principles inspired sustainable models for modern cities", n.d.

ceilings of the rooms on the upper floors. There was also a large tank situated in front of the castle and collecting the water flowing from the internal fountain. These large volumes of water, besides hosting a large number of colourful fish and water plants, had a bioclimatic function."

The authors provide many more details than I can reproduce here. Alas, none of the several accompanying photos specifically feature the ventilation shafts or chimneys (unless they are hidden above the *muqarnas*es).

Dana Katz in her imposing 2016 doctoral thesis on multi-cultural exchange in the Norman palaces of 12th-century Sicily provides a detailed description of the ventilation system of the Zisa Palace which springs the bounds of art history.[78] I shall not begin to even summarize it, in order to encourage readers to consult it for themselves. Worthy of mention is her reference to a 2,000-year-old Iranian tradition (my emphasis):

> "The windtowers that flank the palace are another key constituent of the passive air cooling system in place.* These two rectangular towers are 26.50 meters high. **They utilize an ancient technology that was developed in the arid regions of Iran roughly two millennia ago.** Functioning in an opposite manner to chimneys, these towers funneled air from above and distributed it to different floors through a series of vents.*"

Katz' remarks on related later phenomena in later Crusader castles in the Levant are important, and are here slightly modified, with her footnotes expanded below:

> "Similar ventilation systems can be found in later Ayyūbid military castles and their residences, for instance at Shawbak (the Crusader castle of Krak de Montréal / Mons Regalis), first built by Baldwin I of Jerusalem and conquered by Ṣalāḥ al-Dīn. Ventilation shafts have been recently identified by a team of Italian archaeologists in the fortification's

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78 Dana Katz, *A Changing Mosaic: Multicultural Exchange in the Norman Palaces of Twelfth-Century Sicily* (2016), esp. pp. 232-234. The available version is without illustrations.

> residential complex dating to the Ayyūbid period (Rugiani, pp. 212-214). Another example is present in the Ayyūbid citadel in Damascus, located to the sides of the northern and western *īwān*s of the principal courtyard and in other spaces in the northeastern and eastern parts of the citadel. At Qalʿat Najm on the Euphrates there was also a ventilation system (Yasser Tabbaa, p. 90; Yovitchitch, p. 124)."

A study from 2018 by four environmental engineers focusses on the Zisa Palace and provides photos of the relevant components of the ventilation system – **Pl. P10**.[79] The historical information provided is minimal:

> "'Wind towers' (common [*sic*] in Arabic [*sic*] architecture) are another example of passive ventilation and well-known structures that apply the principle of natural convection to cooling. A wind tower is constructed from the foundations of a building and undergoes internal subdivisions into a series of chimneys and vertical ducts before emerging at the top of the building. ... ."

A reference takes the reader to Mehdi Bahadori's ground-breaking 1978 *Scientific American* article on Iranian wind-towers, in which nothing 'Arab' is mentioned. What is "well-known" now are the wind-towers in Iran, which had no influence on anything Norman.

Somehow it seems that we have not advanced. It would certainly be a good idea for someone informed about 'Arab' ventilation-schemes to have another look at these Sicilian ones. Unless I am mistaken, they do not feature in the most reliable surveys of Islamic technology and engineering (Wiedemann *et al*. & Hill & al-Hassan) or even *1001 Inventions*.

Some medical sources

> "Islamic civilisation developed a system of healthcare that, at its apogée, was envied by both friend and foe. Therefore, medicine

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79 Laurini & De Vita & De Berardinis & Friedman, "Passive ventilation for indoor comfort: a historical building in a temperate climate" (2018): 1-20, esp. p. 3.

evolved into a highly complex and variegated discipline from the 7th to the 21st century in the various lands of Islam. Medicine transcended the confines of country and creed, as physicians from diverse religious, linguistic, and ethnic backgrounds shared in its scientific discourse." Peter Pormann, ed., *1001 cures – Contributions in Medicine & Healthcare from Muslim Civilisation* (2018).

"Don't sleep in the *bādahanj*
For there is no medicine for those made sick by it.
The individual that steals passion (air)
At night is not safe."
The poet Ṣadr al-Dīn Ibn ʿAbd-al-Ḥaqq, Cairo, d. *ca*. 1380, cited in Rosenthal, "Poetry and architecture: The *Bādhanj*", p. 19.

Another obvious potential source are medical treatises, many of which discuss air in one context or another as it relates to health. Modern surveys of the history of Islamic medicine do not treat of this topic, let alone the wind-catchers that were to be found in various regions.[80] The modern claim in the Arabic literature that every hospital had a wind-catcher needs to be investigated.[81] In an important study of medieval Arabic medical treatises dealing with environmental pollution, the Saudi historian of Islamic technology Lutfallah Gari identified 20 treatises on the subject

[80] Pormann & Savage-Smith, *Medieval Islamic medicine* (2007), and Pormann, ed., *1001 Cures – Contributions in medicine & healthcare from Muslim Civilisation* (2018).

[81] Dilli, "Cooling devices in the Abbasid Age" (2017), p. 226: في العصور العباسية المتأخرة استخدمت الملاقف في جميع المستشفيات والبيوت, "in the late Abbasid period *malqaf*s were used in all hospitals and houses", with no milieu mentioned and no source cited.

There is not word about this in Ahmed Ragab, *The medieval Islamic hospital – Medicine, Religion, and Charity* (2015).

before 1300, some of Egyptian provenance.[82] It is beyond the scope of the present study to embark on an investigation of even the Egyptian treatises. The references of al-Rāzī, Ibn Sīnā, and Ibn Buṭlān must suffice here, but the sources identified by Lutfallah Gari offer fertile ground for future research.

Here we present citations from medical treatises compiled by the leading Muslim scholars on the subject, each of whom happened to mention the *bādahanj*. Their statements are, for our purposes, somewhat disappointing. The wind-catchers do not feature significantly in medical treatises because they relate more to common sense rather than to medical practice.

al-Rāzī

Abū Bakr Muḥammad ibn Zakarīyā al-Rāzī (854-925) was one of the leading writers on medicine in medieval Islamic civilization. As his epithet indicates, he came from the city of al-Rayy, near modern Tehran. His multi-volume work on medicine was appropriately entitled الحاوي في الطب, *al-Ḥāwī fi ʻl-ṭibb*, *The All-encompassing Work on Medicine*.[83]

In the Wikipedia article on "Medicine in the medieval Islamic world" we read:[84]

> "Rhazes considered the influence of the climate and the season on health and well-being, he took care that there was always clean air and an

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82 Lutfallah Gari, "Arabic treatises on environmental pollution up to the end of the thirteenth century" (2002), at www.environmentandsociety.org/node/3141.

83 On al-Rāzī and his works see Sezgin, *Geschichte des arabischen Schrifttums*, III (1970), pp. 274-294. For general information see the articles in *DSB* by Shlomo Pines and in *Enc. Islam*, 2nd edn., by L. E. Goodman, both philosophical rather than medical. For the latter see Pormann & Savage-Smith, *Medieval Islamic Medicine* (2007), *passim*.

84 https://en.wikipedia.org/wiki/Medicine_in_the_medieval_Islamic_world.

> appropriate temperature in the patients' rooms, and recognized the value of prevention as well as the need for a careful diagnosis and prognosis."

There is inevitably no reference to an original source.

Hamdia Dilli mentions that al-Rāzī wrote on the wind-catcher but does not record what he wrote, which is doubly unfortunate because her reference to the Hyderabad edition of the *Ḥāwī* is incorrect.[85]

Confronted by the entire 1963 Hyderabad edition in 25 volumes, I resisted the temptation to try to find the quote. I suspect that the reference would be similar to what was written by Ibn Sīnā. On the other hand, a common claim in the modern Arabic literature is that there were *bādahanj*es in every hospital during the medieval period, but no source is ever given. al-Rāzī started his career as director of a hospital, so his remark about *bādahanj*es is worth pursuing. The first place to look would be the 1942 doctoral dissertation at Harvard University of the Turkish historian of science, Aydın Sayılı (1913-1993), which constituted the first history of the observatory and the hospital in Islam, both parts based on original Islamic sources, but of which only the first part was ever published.[86] In the English translation of a 1980 Turkish summary by Sayılı there is no mention of this tradition.[87] Likewise, there is no mention of it in the 2007 book *Medieval Islamic medicine* by Peter Pormann and Emilie Savage-Smith.

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85 Dilli, "Cooling devices in the Abbasid Age" (2017), p. 230, citing *al-Ḥāwī*, Hyderabad edn., II, p. 203.

86 Sayılı, *Institutions of Science and Learning in Medieval Islam*, Ph.D. thesis, Harvard University, 1942. This was alas never published in its entirety. Fortunately, Sayılı's *The Observatory in Islam* was published in 1960 and is still available. Very little of consequence has been written on the subject since: see the survey article "Marṣad (observatory)" in *Enc. Islam*, 2nd edn., by Julio Samsó, which, as the author says, draws extensively on Sayılı's ground-breaking work.

87 Sayılı, "The hospital in medieval Islam" (English transl. from the original 1980 Turkish article).

Ibn Sīnā

The illustrious philosopher and medical scholar Ibn Sīnā (980-1037) in his monumental *magnum opus* ,القانون في الطب *al-Qānūn fi al-ṭibb*, *Canon of medicine*, mentions using a *bādahanj* to provide fresh air and to cool the room.[88]

> كلما كانت المنطقة المحلية تتسم بالحر الشديد فانه يجب ان تتخذ فوق ابنيتها بادهنج او اكثر يتصل بالسرداب المفضي بدوره الى قاعة الجلوس التي تجتمع فيها الناس وذلك لازاحة الهواء الثقيل المنحصر فيها اولا وتبريدها ثانيا
>
> "The more the local region is characterized by extreme heat, the more it is necessary to place above the buildings a *bādahanj* or (even) more (than one), which should connect (vertically downwards) with a (grilled) vent (*sardāb* [usually meaning underground water reservoir]) leading in turn to a sitting room in which people gather, this being firstly to remove the heavy air that is confined in (the room) and secondly to cool (the room)."

It would be interesting to know where Ibn Sīnā learned of the *bādahanj*. He was born in Afshana near Bukhara, but wrote this medical *magnum opus* – his total output was 270 titles – in Jurjan, Rayy (near modern Tehran) and Hamadan. Since he borrowed extensively from al-Rāzī's major medical work *al-Ḥāwī*, future researchers should check there.

The importance of *al-Qānūn* and its influence in the Muslim world and in medieval and Renaissance Europe is well documented. A Latin translation was published in Milan in 1473 and reprinted numerous times, and the

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88 On Ibn Sīnā and his works see an overview of the contents of his major medical work see the *DSB* article (Suppl. pp. 498-501) by the Egyptian historian of medicine Albert Zaki Iskandar. See also the article Ibn Sīnā" in *Enc. Islam*, 2nd edn., by the French Arabist Anne-Marie Goichon. On his influence in Islamic medicine see Pormann & Savage-Smith, *Medieval Islamic Medicine* (2007), *passim*. For his philosophical works see numerous publications by Dimitri Gutas.

For this text see Ibn Sīnā, *al-Qānūn fi al-ṭibb*, I, p. 203, also cited in Dilli, ... اجهزة التبريد / "Cooling devices in the Abbasid Age" (2017), p. 115.

work served as a textbook at the universities of Montpellier and Louvain until 1650. Given the importance of this work, I find it surprising that the only Islamic source I have encountered in which Ibn Sīnā is mentioned in connection with the *bādahanj* is the travelogue of Evliya Çelebi (see below).

ʿAlī ibn Riḍwān

Max Meyerhof (1874-1945), a German Jewish opthalmologist who became an Egyptian citizen, was one of the scholars to put the history of Islamic medicine "on the map". His colourful but sad life was enriched, and saved, by the fact that his cousin was an Egyptologist, and for this reason he visited Egypt and eventually settled there, with interruptions, and opened a practice. He had the 'honour' to be the first German whom the British let back into Egypt in 1922. In the evenings when his practice in Cairo was closed, he devoted himself to the history of Islamic medicine.

Meyerhof made an exciting find in the Khedivial Library (now Dār al-Kutub al-Miṣriyya). This was a pair of manuscripts (*ṭibb* 18 and 384) of a treatise by the Cairo physician ʿAlī ibn Riḍwān (998-1061 or '69) entitled *Fī dafʿ maḍarr al-abdān bi-arḍ Miṣr*, *On the prevention of bodily ills in the land of Egypt*.[89] Ibn Riḍwān was chief physician to the Caliph al-Ḥākim, and thereafter worked as a popular practitioner under the Caliph's two successors. The author says he was impelled to write it by a short treatise by a Tunisian physician, Ibn al-Jazzār, which had been written without personal experience of Egypt. Meyerhof published a significant extract from the treatise in German in 1923, with the Physical-Medical Society at the University of Erlangen, which was at the time the leading center in the world for the study of the history of Islamic science, thanks

[89] See the *DSB* article "Ibn Riḍwān" by the French orientalist Roger Arnaldez (1911-2006) and the article "Ibn Riḍwān" in *Enc. Islam*, 2nd edn. by the British-German orientalist Joseph Schacht (1902-1969).

to the presence there of Eilhard Wiedemann and his colleagues and students. The English version appeared in 1929 in the proceedings of the International Congress of Tropical Medicine and Hygiene, held in that year in Cairo. Both articles were reprinted by the Institute of Arabic-Islamic Science in Frankfurt in 1992 in the series *Islamic Medicine*. (This is a very good example of how scholars (are sometimes forced to) publish their work, and of why their work often remains inaccessible.)

Ibn Riḍwān's treatise deals in 15 chapters with the following main topics: 1) description of Egypt; 2) its climate; 3) six factors which determine health and disease in Egypt (air, food, bodily exercise, sleep, excretions, psychical conditions); 4) the seasons in Egypt; 5) that most of what Ibn al-Jazzār relates is incorrect; 6) on Cairo itself (this chapter translated by Meyerhof); 7) on the causes of plague; 8) further commentary on the six factors mentioned in Ch. 3; 9) general exposition on hygiene and medical treatment; 10) what the doctor must do in Egypt; 11) prescription of rules of life; 12) on the mitigation of the harmfulness of air, water and food in Egypt; 13) on the prevention of the ills caused by the diseases prevalent in Egypt; 14) prescriptions; and 15) hygienic rules for the inhabitants of Egypt.

Meyerhof translated Chapter 6, which offers fascinating insights into the Cairo scene of his time, but where there is no detailed mention of the winds, let alone of *bādahanj*es. That leaves another 14 chapters where there just might be. What he does relate is the condition of the various parts of the city as far as cleanliness (or the opposite) is concerned, and the effect of weather on conditions in the urban complex.

Ibn Riḍwān (Ch. 9) includes tirades against ignorant colleagues, particularly surgeons and oculists, and tells of one who never looked at a patient without first determining his horoscope with an astrolabe,[90] and

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[90] On the astrolabe see n. 514 below. For this tale, see p. 124 of Dols' translation.

In fact, one cannot cast a horoscope with an اسطرلاب, *asṭurlāb*, astrolabe alone. One needs a تقويم, *taqwīm*, ephemeris, as well, which gives the positions of the sun,

another physician, a venerable, long-bearded old man, who could neither read nor write. These would surely be fascinating to read, but until 2020 I was not aware that anyone had published the treatise or translated it.

It was inevitably my former colleague, the American historian of medicine in the Near East, Michael Dols (1942-1988), who, together with his Egyptian colleague Adil Gamal, did precisely that in their 1984 publication *Medieval Islamic Medicine* ... .[91] There is considerable information on the winds in the different suburbs of the city. However, I quote from Ch. 12 on the means of improving the badness of the air, water, and food in Egypt:[92]

> "The first thing that is necessary in this matter is that the houses and living rooms be spacious, so that much of the vapor is dissolved. The buildings should have an opening in order that the vapor may escape and the rays of the sun may enter. ... ... "

Now the Arabic word here rendered as 'openings' is مخارق, *makhāriq*, which indeed refers to a hole that has been pierced (خرق) in a ceiling or a wall. This is an inappropriate term either for a ventilation shaft or for a *vasista*, but it is, alas, the closest we are going to get to a wind-catcher in this text. Michael refers to the *Encyclopaedia of Islam* article on the Persian *bādgīr*s, as well as the studies of Lézine (architecture) and Rosenthal (poetry). He also refers to the Venetian Alpino and his remarks

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moon and five naked-eye planets for each day of a given year – see further **Chs. 12-13**. With the astrolabe one can find the time of day or night and the instantaneous positions of the astrological houses. The ephemeris will enable one to situate the seven celestial bodies in the houses and make predictions from their relative positions. Such predictions always have a 50% chance of success.

91 Michael Dols (transl. & intro.) & Adil S. Gamal (edition of Arabic text), *Medieval Islamic Medicine, Ibn Ridwan's Treatise 'On the Prevention of Bodily Ills in Egypt'* (1984), esp. p. 63 & 95 on the winds in Cairo.

92 *Ibid*., p. 131.

about wind-catchers, and it was he who kindly told me about Alpino. The year 1984 marked a turning point for the *bādahanj*.

Ibn Buṭlān on the *bādahanj*es of Aleppo

The Aleppo historian Muḥammad Rāghib al-Ṭabbākh (1876-1950) in his monumental history of Aleppo related the following from a treatise by Ibn Buṭlān, the well-known Christian Arab medic of Baghdad, Mukhtār ibn al-Ḥasan ʿAbdūn (*ca*. 1000 - 1086).[93] In 1049 Ibn Buṭlān visited al-Raḥba, al-Ruṣāfa, Aleppo, Antioch, Lattakia and Jaffa on his way to Cairo. Later he spent three or four years there. In Aleppo he had been preoccupied because "he was an utter failure with the Christians, whose community he wanted to dominate and whose religious life he wanted to reform" (Arnaldez). The literary output of Ibn Buṭlān was very diverse and "distinguished by its originality" (Schacht) and is only partly extant.

This treatise of his deals with the reason why treatment by the Ancients of various diseases using hot medicines had been changed in his time to treatment with cold medicines.[94] It had been compiled in Antioch in 455

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93 On Ibn Buṭlān see the article in *DSB* by the French orientalist Roger Arnaldez (1911-2006) and *Enc. Islam*, 2nd edn., by the British-German orientalist Joseph Schacht (1902-1969), esp. col. 741b, no. 6 on his travel accounts. Some of these, but apparently not all, have been used to document the history of medieval Palestine and the Crusades. For more on this treatise see Schacht & Meyerhof, *The Medico-Philosophical controversy between Ibn Butlan & Ibn Ridwan* (1937), p. 65, no. 7. Alas that controversy, fascinating though it may be, starting with a refutation by Ibn Buṭlān of the claim that a chick is warmer than a chicken, and whilst attaining lofty philosophical heights, but also descending into an exchange of personal insults, is not relevant to our subject.

94 Rāghib al-Ṭabbākh, *Iʿlām al-nubalā' bi-ta'rikh Ḥalab al-shahbā'*, *Introducing the noble scholars in the history of Aleppo 'the Gray'*, IV, p. 186. On the orange in the Islamic world see the article "Nārandj" by the prolific Arabist and natural historian François Viré in *Enc. Islam*, 2nd edn.

Hijra (1063) after the medic was entrusted with the construction of the hospital there, and the following extract is relevant to our study:

> وقال في اثناء هذه المقالة ومما تدل ايضا على اختلاف احوال البلاد بتنقل القرانات ما حكاه لنا مشايخ اهل حلب ان شجرة النارنج ما كانت تنبت بحلب لشدة بردها وان الدور القديمة كلها لم تكن تستطاع السكنى في الطبقة السفلى منها وان البادهنجات حدثت منذ زمن قريب حتى ان لا دار الا وفيها عدة بادهنجات بعد ان لم يكن بحلب ولا واحد

> "(Ibn Buṭlān) said in this treatise that what indicates also the change of (climatic) conditions in countries (associated) with the passing of centuries is what the elders amongst the citizens of Aleppo related to the effect that the orange (tree) did not used to grow in Aleppo because of the severe cold (in winter, but now it does), and that in old houses living was not possible in the lower floor (because it was so cold), and that wind-catchers have appeared only recently to the extent that every house has several wind-catchers, after (all that time when) there was not a single (wind-catcher here)."

The Aleppo historian Sheikh Kamel al-Ghazzī, in his 3-volume *Nahr al-dhahab fi ta'rīkh Ḥalab*, *The Golden River in the History of Aleppo*, published in 1922, made the following statement:[95]

> ان الباذهنجات (ملاقف الهواء) حدثت في حلب منذ زمان لم يكن بها دار الا وبها باذهنج بعد عدم وجودها مطلقا.

> "*Bādhahanj*es, known these days as *malāqif al-hawā'*, wind-catchers, are only recently to be found in Aleppo. Since a while now there is not a house without a *bādhahanj*, after there had been (in the past) none at all."

al-Ghazzī says his own investigations lead him to the opposite conclusion of what Ibn Buṭlān had claimed (ظهر لنا فيها عكس ما ادعاه المختار). What is beyond doubt is that ʿAbd al-Laṭīf al-Baghdādī said virtually the same thing about the houses of Cairo some 50 years later – see below.

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95 Kamel al-Ghazzī, نهر الذهب فى تاريخ حلب, *Nahr al-dhahab fi ta'rīkh Ḥalab*, *The Golden River in the History of Aleppo*, 3 vols., (1922), available on the internet.

In any case, these remarks of Ibn Buṭlān are of great historical interest, referring first, to an instance of what we now call "climate change"; second, to the introduction of orange trees where previously it had been too cold; and third, to changes in domestic architecture about which nothing was known previously. Or is that really the case?

Did the weather in the Aleppo region really become warmer? And what did these *bādahanj*es look like? I have no idea. Why and when did they disappear? I do not know. I know of only one textual reference.

To my surprise I found out that there was indeed a change in the climate in Syria about a millennium ago, but not as indicated in our text.[96]

Later I shall confront the fact that the supposed *malqaf*s of the 13th-century Ẓāhiriyya Madrasa in Aleppo are facing a direction that would

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[96] See Kaniewski & Van Campo & Paulissen & Weiss & Bakker & Rossignol & Van Lerberghe, "The medieval climate anomaly and the little Ice Age in coastal Syria inferred from pollen-derived palaeoclimatic patterns" (2011). Their summary reads:

> "The alluvial deposits of a small spring valley near Jableh, in north-western coastal Syria, provides a unique record of environmental history covering the last 1000 years. The pollen-derived climatic proxy inferred from a 315 cm deep core of alluvial deposits suggests that a shift towards wetter climatic conditions occurred from circa (ca.) 1000 to 1250 calibrated (cal) yr AD. This period is situated within the time frame of the Medieval Climate Anomaly. The reconstructed temperature trends show that the warming during this medieval episode was not as high as the modern scores, except for short intervals during the early 12th century AD. The core also recorded a shift towards drier conditions starting during the late 12th century AD, which represents the Eastern Mediterranean expression of the European "Great Famine" climatic event. The main dry and cool interval recorded in coastal Syria occurred from ca. 1520 to 1870 cal yr AD, a time frame encompassing the Little Ice Age. In Mediterranean Syria, the Little Ice Age is not only cooler, but also much drier than the Medieval Climate Anomaly and the present-day climate. Despite a strong human presence in coastal Syria throughout the last millennia, climate rather than anthropogenic activity seems to be the driving force behind the natural vegetation dynamics in this region."

Their article, which has a substantial bibliography, does not draw on any medieval texts.

only allow the cold winter winds to blast down onto the *miḥrāb* of the prayer-hall of the Madrasa: see **Ch. 11**.

Ibn Khātima and the Plague

The vast medical and historical literature dealing with the Plague in the Near East in the 14th century has been surveyed in a masterly fashion by Michael Dols (see above).[97] I looked in vain in his groundbreaking book for Egyptian sources promoting the advantages of enjoying fresh air in front of a *bādahanj*, but found nothing of the sort. There are records of numerous historical events involving winds. Michael cites the 14th-century Andalusī intellectual, poet and historian, Ibn Khātima, who wrote a treatise on the pandemic. Michael summarizes the causes Ibn Khātima identifies for the Plague:

> "In his lengthy discussion of the corruption of the air, he conveniently distinguishes for us the three remote causes of plague miasma frequently encountered in the medieval accounts: (1) the irregularity of the seasons, either in temperature, rains, or winds; (2) the putrid fumes arising from decaying matter on the earth; and (3) astrological events. The first explanation is considered by the author to be the most probable one for the pandemic. Ibn Khātima drew this theory of natural causation of the disturbance of the four natural elements from Hippocrates."

Amongst the precautions one should take, Ibn Khātima specifies the following:

> "Men should avoid the permitted (beverages) as well as the prohibited wines (made from them), all kinds of milk because of the fermentation, and bad water. (Also) **it is best to get a normal night's sleep with the room open to the north wind**. (Also) whoever is exposed to plague should avoid constipation by eating cooked plums, violets, tamarind, *etc*.

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[97] Dols, *The Black Death in the Middle* East (1977), esp. pp. 104-105. On Ibn Khātima see the article by the Spanish Arabist Soledad Gibert in *Enc. Islam*, 2nd edn.

> Baths and cohabitation should be avoided, while bloodletting is strongly recommended."

The orientation of the bedroom would be optimal in Cairo, and for Almería, where our author spent most of his life, who knows?

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The above references show that there were indeed *bādahanj*es in early medieval al-ʿIrāq. What happened thereafter, which I leave to others, is less clear than what happened in medieval Cairo, to which we now turn. The place where we might expect to find something about healthy breathing and fresh air in Cairo, and how this can be achieved, is disappointing. This is the treatise on pulmonary transit by the renowned 13th-century Cairo physician-jurist Ibn al-Nafīs, who is, alas, silent on our issue.[98]

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[98] See Nahyan Fancy, *Science and religion in Mamluk Egypt – Ibn al-Nafīs, pulmonary transit, and bodily resurrection* (2013).

4 — The Cairene wind-catchers in textual sources

> "No other city in the Islamic world offers a legacy as rich in architectural examples or in urban development as Cairo. For centuries Cairo, "peerless in beauty and splendor," has been adorned by its monuments, and within its metropolitan confines there has existed a paradigm of many types of Islamic settlements: for example, the military-garrison (Fustat), the princely enclave (al-Qahira), the military-administrative-residential fortress (the Citadel), the 19th century colonial city of the Khedive Isma'il."
> Caroline Williams, review of books by Nelly Hanna on Bulaq and Doris Behrens-Abouseif on Azbakiyya (1986), pp. 218-219.

With the following words, a one-day symposium entitled "Fustat and the World in the Year 1000" held at the Bard Graduate College in New York City on 06.11.2015 was introduced on the Bard website:[99]

> "Fustat, founded as a military encampment by the armies of the Arab conquests in the seventh century, served as the center of a flourishing global network of trade that connected the Indian Ocean via the Red Sea to the Mediterranean. After the Fatimid caliphate moved from modern-day Tunisia to Egypt in 969 and founded Cairo (*al-Qāhira*) as its new capital city two miles northeast of Fustat, both cities continued to thrive. As the commercial center of the powerful Fatimid empire, Fustat's craftsmen competed in the production of luxury products including lusterware, elaborate textiles and carved ivory objects, which were then carried by traders and diplomats through the Mediterranean and beyond."

So Fatimid craftsmen produced all manner of luxury objects. Anything else? It happens that Fustat-Cairo was home to the leading astronomer of medieval Egypt, Ibn Yūnus, much neglected in modern times because his

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[99] www.bgc.bard.edu/research-forum/articles/145/fustat-and-the-world-in.

works were unknown in medieval Europe, and the leading Muslim scholar of physics and optics, Ibn al-Haytham, known as Alhazen in Latin, whose works did indeed become known in medieval and Renaissance Europe. Maybe a reference to these two scholars would not have been amiss? In this study we shall focus on Ibn Yūnus but shall also mention his late contemporary Ibn al-Haytham.

This lack of interest amongst modern scholars does not alter the fact that wind-catchers were a prominent feature of Cairo-Fustat from the 10th to the 19th century. One consequence of this is that they are mainly only mentioned by visitors. We know of their profusion from poetry and from scientific texts, but these may be somewhat hard to digest. Therefore, we begin with references to them in medieval and early modern travel literature and occasional historical and legal documents, and then proceed to more recent representations by artists and documentation by photographers. I do not doubt that there are references to *bādahanj*es in a series of other Egyptian historical works in Arabic from the 10th to the 19th century, but these are still mainly undocumented.[100]

An attestation from the time of the Caliph al-Muʿizz

The Egyptian historian Ibn ʿAbd al-Ẓāhir 1223-1292) is reported to have written of بادهنج المنبر, "the *bādahanj* of the *minbar*", as part of the furnishings of the al-Azhar Mosque already in the year 362 Hijra (972/73). The Fatimid ruler al-Muʿizz (*reg*. 953-975) used to preach a sermon at Ramadan at the Mosque, founded in 970, and thereafter in the Mosque of

[100] King, "Architecture and astronomy", p. 103, n. 24 / *Synchrony*, VIIc: 788, n. 7, mentions references to *bādahanj*es in the following historical sources: (1) Ibn Taghrībirdī's description of the al-Azhar Mosque (IV, p. 102); (2) the history of Ibn Ḥabīb (p. 345); (3-4) al-Maqrīzī's *Khiṭaṭ* (2:1, p. 222) and *Sulūk* (3:1, p. 281). I have not pursued these sources further.

al-Ḥākim.[101] This is related by the 15th-century Egyptian historian Ibn Taghrībirdī:

> ... واما خطبة الخليفة (المعز) في شهر رمضان ... وكان اذا اراد ان يخطب يتقدم متولي خزانة الفرش الى الجامع ويغلق المقصورة التي برسم الخليفة والمنظرة وابواب مقاصيرها وبادهنج المنبر ثم يركب متولي بيت المال ... . وكان ذلك بجامع الازهر قبل ان يبني الحاكم جامعه ثم صار بعد ذلك بجامع الحاكم ...
>
> "When the Caliph al-Muʿizz wanted to deliver the sermon in the month of Ramadan, the person in charge of the store-room of furnishings would come to the Mosque and he would close the special space reserved for the ruler (*maqṣūra*) which was under the supervision of the Caliph, and the reception room (? *manẓara*), and the doors of the (other) special spaces (pl. of *maqṣūra*), and the *bādahanj* close to the pulpit (*minbar*). Then the person in charge of the treasury would do this and that ... . That was in the al-Azhar Mosque before al-Ḥākim built his Mosque, and when that happened, this event took place in al-Ḥākim's Mosque."

al-Muqaddasī

The 10th-century geographer Shams al-Dīn al-Muqaddasī (or Maqdisī) from Jerusalem has left us valuable accounts of localities he visited between 960 and 985.[102] In particular, of the Egyptians he related:

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101 See the article "Ibn ʿAbd al-Ẓāhir" in *Enc. Islam*, 2nd edn., by Johannes Pedersen. The reference is in Ibn Taghrībirdī, *al-Nujūm al-ẓāhira*, IV, p. 102 dealing with events of 362 H, cited in Rosenthal, Poetry and architecture" (1977), p. 1, n. 2. Franz Rosenthal questioned whether the terminology might date from the 13th century rather than the 10th. I am confident that it is from the 10th century. See n. 331 below.

102 Article "al-Muḳaddasī" by André Miquel in *Enc. Islam*, 2nd edn. For this quotation see the edition of his geographical treatise by the Dutch orientalist Michael de Goeje, ed., 2nd edn., pt. I, p. 205, line 14, & IV, p. 183; also Jaubert, "Capteurs de vents", p. 170, n. 10.

On the scheme of sacred geography found in one of the two manuscripts of his treatise on geography, see the article "Makka as centre of the world" (1987) in *Enc.*

ولهم باذاهنجات مثل اهل الشام

"They have wind-catchers (*bā<u>dh</u>ahanjāt*) like the people of Syria."

Presumably this refers to Cairo within decades, if not years, of its foundation. Yet it is not otherwise known that the Syrians had *bādhahanj*es in the 10th century.

Ibn Yūnus

Early mentions of the *bādahanj* in Cairo are in the writings of the astronomer Ibn Yūnus *ca*. 1000. These contain first, information on the orientation of the wind-catchers and their shape, and second, a table for orienting a wind-catcher. We shall return to these in **Part Ib**.

Nāṣir-i Khusraw

The scholar Nāṣir-i Khusraw (1004 - *ca*. 1075) from Central Asia visited Egypt in 1047 and stayed there for three years to further his Ismāʿīlī education. He observed in his travelogue entitled *Safarnāme* that most houses in Cairo had five or six storeys but did not mention the wind-catchers on these houses.[103] One might be tempted to think that this is all the more surprising because such devices are a prominent feature of Iranian architecture.

Islam, 2nd edn.; Schmidl & Herrera, "The earliest known schemes of Islamic sacred geography" (2008), pp. 285-296; and King, "Finding the qibla by the sun and stars" (2019), no. 2.

[103] On the author see the article "Nāṣir-i Khusraw" in *Enc. Islam*, 2nd edn., by Azim Nanji. For this quote see Nāṣir-i Khusraw, *Sefer Nameh: Relation du voyage de Nassiri Khosrau*, ed. Charles Schefer, 1881, p. 132, already in King, *Synchrony*, II: 785. (I have not seen the parallel Persian-English text by Wheeler Thackston.) See also the article "Fusṭāṭ" by Jacques Jomier (1914-2008) in *Enc. Islam*, 2nd edn., pp. 957-959, esp. p. 958, and further Abu-Lughod, *Cairo: 1001 years of the City Victorious* (1971), p. 19. See also http://nasirkhusraw.iis.ac.uk.

In a short article on Fatimid Cairo, the British architecture historian Martin Shaw Briggs (1882-1977)[104] in 1920 cited an extract from Stanley Lane-Poole's summary of Nāṣir's description:[105]

> "The royal city, Cairo itself (then called el-Kahira el-Mo'izziya) was a very large town when he saw it in 1046-49; the houses, roughly estimated at 20,000, were built chiefly of bricks, so carefully joined that they looked like squared stone, to the height of five or six storeys, and separated from other houses by well-cultivated gardens and orchards, irrigated by wells and water-wheels. The rent of a moderate-sized house was 11p a month (or about £70 a year), and the landlord of the house in which the traveller lodged refused £5 a month for the top storey. All the houses in Cairo belonged to the caliph, and the rents were collected every month. The shops, which were reckoned at 20,000, were also his property, and were let at from 2p to 10p a month, which, even taking so low an average as 5p represents an annual income of about £650,000. The old wall of the city was no longer standing in 1046, and the second wall had not yet been begun; but the Persian traveller was struck by the high blank walls of the houses and still more of the palace, the stones of which were so closely united that they looked like a solid block. His account of the interior is disappointingly brief, but he mentions the celebrated throne-room, with its throne of gold sculptured with hunting scenes, surrounded by a golden lattice-screen, and ascended by silver steps. He was told that the palace contained 30,000 people, including 12,000 servants, and that the guard mounted every night consisted of 1,000 horse and foot. ... Nāṣir-i-Khusrau found Egypt in a state of the utmost tranquillity and prosperity. In the turbulent period that followed, the caliph was dependent on foreign governors and foreign mercenary troops. His fortunes sank to a very low ebb. He was forced to sell nearly all his enormous treasure collected during a century of despotic affluence, including a library of over 100,000

[104] Martin Shaw Briggs published in 1924 a book with the title *Muhammadan architecture in Egypt and Palestine*. A reprint by the Da Capo Press of New York in 1974 bears the same title, now doubly anachronistic.

[105] Briggs, "The Fatimite architecture of Cairo" (1920), pp. 138 & 143

books."

Where have all those books gone?

The Cairo Geniza

S. D. Goitein and *A Mediterranean Society*

When the documents of the Jewish community of the metropolis of Fustat, preserved for centuries in the Ben Ezra synagogue, were rediscovered in 1896, they provided an explosion of new light on daily life there in medieval times, not only in the Jewish community.[106] The documents had for centuries been preserved in a בית גניזה, *bēt genīza*, "a place of storing". They are written in Judaeo-Arabic, that is, Middle Arabic written in Hebrew script.[107]

The first major work to be based on the documents was *The Jews in Egypt and in Palestine under the Fatimid Caliphs* (1920-22) by the reformed rabbi and historian of the 20th century, Jacob Mann (1888-1940).[108]

A corpus of texts from the Cairo Geniza has been meticulously documented by the German-Jewish orientalist Shelomo Dov Goitein (1900-1985) in his monumental study *A Mediterranean Society: The Jewish communities of the Arab World as portrayed in the documents of the Cairo Geniza* (5 vols., 1967-93). Goitein's translations and

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106 For an introduction see www.jewishvirtuallibrary.org/genizah-cairo , also Goitein, *Mediterranean Society*, vol. 1 (1967), pp. 1-28. For several photos of Geniza documents see Reif, "The Jewish heritage of Old Cairo", in Gabra *et al.*, *The History and Heritage of Old Cairo* (2013). This splendid book is appropriately dedicated to three people who have made a difference, one being S. D. Goitein.

107 See the article "Judaeo-Arabic" by Joshua Blau in *Enc. Islam*, 2nd edn., and the article "Judaeo-Arabic" in *Enc. Islam THREE* by David Cohen, Joshua Blau, and Georges Vajda.

108 Mann, *The Jews in Egypt and in Palestine under the Fatimid Caliphs* (1920-22).

commentaries almost bring the community back to life, and every word he wrote on our subject is worth savouring, and, in this case, repeating.[109]

Two of the Geniza documents mention a *bādahanj*, written באדהנג, that is, *b-a-d-h-n-g*. One preserves for us a sale document of 1190.[110] It is a bill of sale for a mansion and other property in Fustat and the following is an extract:

> "The large house has an arched doorway closed by two dark-brown door leaves. Through it one enters a corridor paved with marble in which there are two benches. From the aforementioned corridor one enters a second corridor, through which one comes to a large *qāʿa*, or ground floor, comprising two living rooms, facing one another with folding doors fastened on them, the cross boards and outsides of which are carved. One of the two living rooms is longish, its walls are of marble and it has two passages of carved wood, each of which has a door leading to an adjacent cabinet. The reception hall has on its 'front' (*i.e.*, the wall opposite the entrance) a 'wind catcher', or ventilation shaft, whose floors and walls are of marble. In front of the ventilation shaft there is a gilded washbasin. The reception hall is encircled by a gilded cornice. On the aforementioned ventilation shaft there are folding doors, the cross boards and outsides of which are carved. The ceiling of the room is painted in oil according to the Syrian fashion. The second living room, which faces the first one described before, has folding doors on its entrance, and on its front a ventilation shaft with folding doors, all of whose cross boards and outsides are carved. The 'front' is of marble in different colors. … … ."

Goitein's commentary, which has references to Revault & Maury, *Palais et maisons*, 1975, and Rosenthal 1977, reads:[111]

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[109] Goitein's earliest writings on the *bādahanj* are in his "A mansion in Fustat" (1977), pp. 163-164, 169-179, 175 (Arabic text); and "Urban housing in Fatimid and Ayyubid times" (1978), p. 17.

[110] Goitein, *Mediterranean Society,* IV (1983), p. 79 and n. 177 on p. 371.

[111] *Ibid*., p. 65, and n. 97 on pp. 365-366.

> "In the *qāʿa* mentioned, both rooms had on the wall opposite the entrance, a "wind catcher", or ventilation shaft, the floor and walls of which were of marble. This contrivance, which was intended to carry fresh air from above the roof into the inner parts of a house (both ground floor and upper apartments), must have been rather wide at its lower end, because people slept there to enjoy the cool north wind of the night brought down by the wind catcher. For reasons of privacy, in both *majlis*es the wind catchers had folding doors with carved decorations, and in one there was a gilded wash-basin nearby, certainly for ablutions required after a night's rest. ... ."

The other document is dated 1128 and records that a certain prisoner escaped through the opening in what was possibly a *bādahanj*. At the time of writing I am unable to access the original text and I wonder whether the original mentions a *bādahanj* or simply an "opening for the wind" (possibly فتحة للريح ?). Here is Goitein's summary:[112]

> "The front of a house could feature an "opening for the wind", which was not meant to serve as a window, and, if submitted to structural changes, would give rise to law-suits.* A prisoner escaped through such an air hole, which suggests that usually it was placed high above the ground.* It was found also in upper floors, as in a document from the year 1285, where the living room in an upper apartment had both windows and an "opening for the wind" in the in the wall opposite the entrance. ... ."

More important for the present endeavour than even these colourful reports are perhaps Goitein's statements about the use of foreign vocabulary to refer to different architectural features in these early documents – see the section "Why did the Egyptians call their wind-catchers *bādahanj*?" below in **Ch. 11**.

It is perhaps worthy of note that S. D. Goitein, along with C. Edmund Bosworth and Geert Jan van Gelder, are the only scholars (before Alev Masarwa) who seem to have cited Franz Rosenthal's article on poetry

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[112] *Ibid*., p. 62 and n. 78 on p. 365.

featuring the *bādahanj*. In the summer of 1968 I had the pleasure of taking a course entitled "Muslim personalities" with Prof. Goitein at the University of Pennsylvania. This involved my translating the parts of Ibn Khaldūn's autobiography dealing with his experiences as a Chief Judge in Cairo. When Prof. Goitein first heard that I was a student of Prof. Rosenthal, Goitein expressed his appreciation of his colleague by saying: "Oh, Franz Rosenthal, he has published so much, and he is so young!".

Moshe Gil

Moshe Gil (1921-2014) studied with S. D. Goitein in Philadelphia; he was a renowned Israeli historian specializing in the historical interaction between Islam and the Jews, including the history of Palestine under Islamic domination. In his editions and translations of Geniza documents from Jewish pious foundations (*qōdesh*),[113] Gil records three references to a *bādahanj*. The reader should bear in mind that the the documents are mainly fragmentary.

First, in a bill from *ca*. 1040 for building expenditures we read from Gil's edition, my rendering into more or less correct Arabic, and Gil's English translation:[114]

> ... תמן סבעה חזמ שועב ארבעה עשר דר תמן חזמה חבל כמסה דר תמן סיתה חזמ חריד נצף ורבע דינאר לנשר כשב אלבאדהנח דרהמין ונצף ורבע ואיצא עמל אלבנא יומ פי קצר חמוד אחרתה מע אחרה אלרקאץ סיתה דר ינצף ...
>
> ... ثمن سبعة حزم شعب اربعة عشر درهم ثمن حزمة حبل خمسة درهم ثمن ستة حزم جريد نصف وربع دينار لنشر خشب البادهنج درهمين ونصف وربع وايضا عمل البنا يوم في قصر حامود اجرته مع اجرة الرقاص (؟) ستة درهم ونصف ...
>
> " ... Paid for 7 bundles of twigs, 14 *dirham*. Paid for a bundle of ropes, 5 *dirham*. Paid for 6 bundles of palm branches, $^{3}/_{4}$ *dīnār*. **For sawing the**

113 Gil, ed. & transl., *Documents of the Jewish pious foundations from the Cairo Geniza* (1976).

114 *Ibid*., pp. 187-188 *ad* text 18.

wood for the *bādhanj*, 2 3/4 *dirham*. Plus, work of the mason for one day in the *qaṣr* of Ḥāmūd, his wages, including the wages of the helper, 6 1/2 *dirham*. ... ."

Another text from 1156 contains an account between the *qōdesh* and a certain al-Nādiv, a perfume-maker, tenant of a compound partly owned by the *qōdesh* and known as al-Burj:[115]

... אלדי דכרו מואלמי אלשיוך אנהמ תחאסבו מע אלנדיב ... ... ואן אלרכאמ אלדי פי אלצפה אלדי תחת אלבאדהנג בגמלתה ללוסט ...

... الذي ذكروا معلمي الشيوخ انهم تحاسبوا مع النديب ... ... وان الرخام الذي في الصفة الذي تحت البادهنج بجملته للوسط ...

"The honourable elders declare that they settled the account of al-Nādiv, ... The marble of **the balustrade of beneath the *bādhanj*** will also have its total cost divided in two (between the *qōdesh* and al-Nādiv). ... ."

A third text is an accounting of a *qōdesh* dated 1234:[116]

... עדד אבואב דאר מהרה אבואב מגלס ומקאטע ובאדהנג וגואנבה ...

... عدد ابواب دار مهرة ابواب مجلس ومقاطع وبادهنج وجوانبه ...

"The number of doors of Dār Mahra: the doors of the *majlis*, the lateral wings, the *bādahanj* and its wings ... ."

What 'wings' mean here is debatable. Presumably the text refers to the doors of the *majlis*, that is, those on the main axis of the (rectangular) sitting- or assembly-room and the side doors (called *muqāṭi*ʿ, intersecting), then doors on either side (rather than 'wing' – the Arabic has *jawānib*, sides) of a substantial *bādahanj*.

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115 *Ibid*., pp. 287-289 *ad* text 59.

116 *Ibid*., pp. 435-441 *ad* text 131.

(On the subject of Judaeo-Arabic it may be of interest to mention a remarkable medieval astrolabe with Judaeo-Arabic inscriptions. This seems to be from the Maghrib, and has been dated *ca*. 1300.[117] The main inscription on the rim has given several investigators a lot of trouble over some 60 years since the piece was auctioned at Christie's of Amsterdam and is now in the Khalili Collection in London. It was no easy task to decipher it.[118] The text turns out to be a corrupt version of a 10th-century poem compiled by the astronomer-mathematician-poet Abū Isḥāq Ibrāhīm al-Ṣābi' for the Buwayhid ruler ʿAḍud al-Dawla when the scholar presented him with an astrolabe; this poem appeared in several manifestations between Baghdad and al-Andalus over the centuries, and the astrolabe presents the most distorted version.)

Ibn Shaddād

Ibn al-Shaddād (1217-1285) was born in Aleppo and became secretary to the chancellery and a skilful administrator.[119] After unsuccessful negotiations with the Mongols he fled to Cairo in 1261. He was welcomed by the Mamluk Sultan al-Ẓāhir Baybars, famous for his defeats of the Crusaders (7th Crusade of King Louis IX of France) on the one side and the Mongols on the other, and he remained in Cairo for some 10 years before returning to Syria. It was in Cairo that he wrote an historical topography of Syria and the Jazīra (and perhaps a work on the Yemen).

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117 For a detailed description see Abu Zayed & King & Schmidl, "From a heavenly Arabic poem to an enigmatic Judaeo-Arabic astrolabe" (2011).

118 See, for example, two earlier attempts by Moshe Brown of Amsterdam and Francis Maddison of Oxford in, respectively, *Christie's Amsterdam 1988 Catalogue*, pp. 88-95 (lot 247), and *Khalili Collection Instrument Catalogue*, I, pp. 214-217 (no. 124).

119 Article "Ibn Shaddād" by Dominique Sourdel in *Enc. Islam*, 2nd edn. On Baybars see the article "Baybars I" *ibid*. by Gaston Wiet.

In addition, Ibn Shaddād wrote a history of Sultan Baybars (1223/1228-1277, reg. 1260-1277). In this he mentioned a building called "House of Gold" which Baybars had had built on the Cairo Citadel.[120] The text begins:

> ما عمره بقلعة الجبل منها دار سماها بدار الذهب وتشتمل على ايوان ومجلس وصفتين وحرمية ويعلوها طبقة واحدة على باذهنجها طيارة وجدد بجوار هذه القاعة طباقا عدة ...
>
> "Amongst what Baybars built on the Citadel is a house / residence called "The House of Gold". It contains a reception hall (*īwān*), an assembly room, two banks or shelves over arcades (*ṣuffa*), and a ...?... (?? *ḥuramiyya*). Above the last-mentioned is a single grille (*ṭabaqa*) ...?... (?? *ṭayyāra*, lit., flying). He renovated (?) several other grilles in the neighbourhood of this *qāʿa*. ... ...

It is of interest to compare this with a translation by Nasser Rabbat, a leading specialist on Cairene architecture, whose book on the Cairo Citadel alerted me to this passage. Rabbat summarizes, remaining true to the Arabic:

> "Ibn Shaddād says that the Dār al-Dhahab consisted of a *majlis*, an *īwān*, two *ṣuffa*s, and a *ḥurmiyya*, and was surmounted by a *ṭabaqa* which had a *ṭayyāra* over the *qāʿa's bādahanj*."

The author explains that the word *ṭayyāra*, literally, "something which flies", usually signifies in such a context as this "the room at the top of the whole structure", or, more plausibly, that the *ṭabaqa ṭayyāra*, "flying cover", refers to the cover of the *bādahanj* that is on the roof. Nevertheless, the Arabic text remains partly incomprehensible.

The palace of the Grand Vizier al-Yāzūrī

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120 Ibn Shaddād, *Ta'rīkh al-Malik al-Ẓāhir*, ed. Ahmad Hutait, p. 340. I owe this reference to Rabbat, *The Citadel of Cairo* (1989), p. 121.

One of the books compiled by the great Egyptian historian al-Maqrīzī (1364-1442), to whom we shall return many times, dealt with the history of the Fatimid caliphs.[121] This is his اتعاظ الحنفاء باخبار الائمة الفاطميين الخلفاء, *Ittiʿāẓ al-ḥunafā' bi-akhbār al-a'imma al-Fāṭimiyīn al-khulafā'*, *Lessons for the Seekers of Truth on the History of the Fatimid Imams and Caliphs*, edited by A. Hilmi in Cairo, 1971-73, by Muhammad Abdel Qadir Ahmad 'Ata in Beirut (n.d.?), and again in 2012 by the distinguished Egyptian scholar Ayman Fu'ad Sayyid. I have used the second of these. In this work, al-Maqrīzī writes about a palace constructed for/by (Abū Muḥammad al-Ḥasan ibn ʿAlī) al-Yāzūrī, whose family came from al-Yāzūr near Ramla in Palestine. In Jerusalem he had been guardian of the al-Aqṣà Mosque in 1026. When he moved to Cairo, he worked in the *dīwān* of al-Sayyida Raṣad, the Caliph's mother, and became Chief Judge and later Chief Minister. His growing financial power and political intriguing attracted the attention of the Sultan al-Mustanṣir, who had him put to death in 1058. Presumably al-Yāzūrī was able to enjoy living in his palace for a while before this happened.

Amongst the details of the lavish palace there are mentioned silver water-channels and images of animals as decoration (thought to bring luck), but in particular a *bādahanj* of width "thirty cubits", that is, about 20 metres.[122] Altogether some 150 craftsmen worked on the palace project for nine

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121 On al-Maqrīzī see the article "al-Maḳrīzī" in *Enc. Islam*, 2nd edn., by Franz Rosenthal. His main work on the topography of Cairo and its history, *al-Khiṭaṭ*, with a total of some one thousand pages has still not found a critical editor (is a new edition necessary?) or, perhaps, more important, a translator. An intermediary phase would be the provision of an index, and this was achieved by Aḥmad Harīdī in 1983, although it is not easy to find. Meanwhile, see the enthusiastic article by Martyn Smith, "Getting Maqrizi's Khitat on the Web", at www.scribd.com/docume—*—nt/43578073/Maqrizi-on-the-Web.

For this quote see *Ittiʿāẓ al-ḥunafā',* I, pp. 120-121, of the Beirut edition.

122 Hinz, *Islamische Masse und Gewichte*, (1955), p. 55

years. The word used for the width of the *bādahanj* is طول, *ṭūl*, literally 'length', but this term is used for 'width' in the astronomical texts. The relevant text reads:

> ولها بادهنج طوله ثلاثون ذراعا, "(the palace) had a *bādahanj* which was thirty cubits wide … ."

This text is extremely important for our purposes because it shows that a *bādahanj* of some 20 metres width was part of the scene in Fatimid Cairo, that is, in the mid 11th century. As we shall see below, around the year 1200 ʿAbd al-Laṭīf al-Baghdādī recorded that some *bādahanj*es cost between one hundred and five hundred dinars each, but that small ones for ordinary houses cost no more than one dinar each. What both writers are telling us is that in Fatimid Cairo there were monumental *bādahanj*es such as those we see around 1800 in the Palace of Alfī Beg and the Musāfirkhāne.

Ibn al-Ma'mūn

In the published extracts from the history of Egypt – اخبار مصر – by Abū ʿAlī Mūsà ibn al-Ma'mūn al-Baṭā'iḥī known as Ibn al-Ma'mūn (d. 1192), the son of the Fatimid vizier al-Ma'mūn al-Baṭā'iḥī, we find a *bādhahanj* mentioned in a passage about the price of pistachios (فستق, *fustuq*).[123] I offer no translation because what is written can only be understood within the context of the surrounding text:

> ومنها ما يحمل مختوما برسم المائدتين الآمريتين بالباذهنج والدار الجديدة اللتين ما يحضرهما الا من كبرت منزلته وعظمت وجاهته جامان رطبا ويابسا

A victory *bādahanj*

A brief mention of a *bādahanj* occurs in al-Maqrīzī's treatise *al-Khiṭaṭ* in the context of a celebration of victory in the year 1131. Paula Sanders in

123 Ibn al-Ma'mūn, *Akhbār Miṣr*, ed. A. F. Sayyid, p. 92.

her 1994 book on ritual, politics and the city in Fatimid Cairo has rendered this section as follows:[124]

> "The (Victory) Festival (*ʿīd al-naṣr*) was celebrated without a procession in the *īwān*, which was still decorated with the furniture and drapes from the (Shīʿite) Festival of Ghadīr Khumm. The audience hall known as *al-muḥawwal* was also decorated. A platform (*martaba*) was set up close to the wind-catcher (*bādahanj*) and the military and civilian officials of the state gathered at the Royal Entrance (*bāb al-mulk*) next to the grilled loge (*shubbāk*). The caliph rode mounted to the audience hall and dismounted at the door. ... ."

al-Maqrīzī and two tales of *bādahanj*es

Another of the numerous references which al-Maqrīzī has to a *bādahanj* in his monumental topography of Cairo known as *al-Khiṭaṭ* involves a caliph who had his name inscribed at the top of his *bādahanj*.[125] The text reads:

> ... اسمه مكتوب باعلى بادهنجه الى اليوم ... ,"... his name (has remained) written on the top of his *bādahanj* to this day … ."

It seems to me to be the ultimate earthly privilege to have one's name written on top of a (monumental) *bādahanj*.

Another account by al-Maqrīzī is the following:[126]

> واذا بالنار ابتدات من اعلى البادهنج وكان ارتفاعه من الارض زيادة على مائة ذراع بذراع العمل وراوا فيه نفطا قد عمل فيه فتيلا كبيرة
>
> "Suddenly fire broke out, beginning at the top of the wind-catcher. Its height was more than 100 cubits, in the cubits used in the building business (*bi-dhirāʿ al-ʿamal*?). People threw oil on the fire, which caused many

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[124] Sanders, *Ritual, politics, and the city in Fatimid Cairo* (1994), p. 130, and esp. n. 43 on p. 201, based on al-Maqrīzī, *al-Khiṭaṭ*, I, 357.14-15, 390.1-10 & 490.36-491.4. (On al-Maqrīzī see n. 121 above.)

[125] al-Maqrīzī, *al-Khiṭaṭ*, II, p. 250.

[126] *Ibid*., II:1, p. 222.

fatal casualties."

The building was apparently more than about 70 metres high, one of those five- or six-storey houses described in accounts of travellers to medieval Egypt.[127]

ʿAbd al-Laṭīf al-Baghdādī

The ʿIrāqī philosopher and polymath ʿAbd al-Laṭīf al-Baghdādī (1162-1231) visited Cairo twice during the period 1190-1210, that is, after the destruction of Fustat, and altogether spent several years there.[128] He reported the following (my emphasis):

> الفصل الخامس فيما شوهد بها من غرائب الابنية والسفن واما ابنيتهم ففيها هندسة بارعة وترتيب في الغاية حتى انهم قلما يتركون مكانا غفلا خاليا عن مصلحة ودورهم افيح وغالب سكانهم في العالي ويجعلون منافذ منازلهم تلقاء الشمال والرياح الطيبة وقلما تجد منزلا الا وفية باذاهنج وباذاهنجاتهم كبار واسعة للرياح عليها تسلط ويحكمونها غاية الاحكام حتى انه يغرم على عمارة الواحد منها مائة دينار الى خمس مائة وان كانت باذاهنجات المنازل الصغار يغرم على الوحد منها دينار ... ...

> "The fifth chapter concerning what was observed in (Cairo) in the way of strange and curious buildings and ships. Their buildings reveal a marvellous building-technique (*handasa*) and an extremely fine organization (*tartīb*), to such an extent that they rarely (*qallamā*) leave any

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127 See text to n. 103 above.

128 Zand *et al*., manuscript facsimile & transl., *The Eastern Key* (1975), pp. 178-179, here slightly modified, cited in King, "Ibn Yūnus' *Very Useful Tables*" (1973), p. 372 / *Synchrony*, II: 271; Rosenthal, "Poetry and architecture", p. 1; and King, "Architecture & astronomy", p. 97 / *Synchrony*, VIIb: 781.

On al-Baghdādī see the brief article in *Enc. Islam*, 2nd edn. (1960), by Samuel M. Stern, and the new and rich article by Cecilia Martini Bonadeo, "'Abd al-Latif al-Baghdadi", in *Stanford Encyclopedia of Philosophy* (2015). On the reception of the treatise of "Abdollatiphi" in British academic circles in the early 19th century see the collection of reviews in www.archaeologicalresource.com/Books_and_Articles/—*—Abdallatif/Abdollatiphi_MAIN_Page_and_ENG_Reviews.html?i=1.

> space neglected or without purpose. Their houses (*dūr*) are vast and most people make their abode in the upper quarters. They make the openings of their houses to face the north and the favourable winds. **Rarely (*qallamā*) does one find houses without a wind-catcher (*bādhāhanj*). These wind-catchers of theirs are tall and wide, and open to every action of the wind; they are erected carefully and with much skill. One can pay between one hundred and five hundred dinars for a single ventilator, but small ones for ordinary houses cost no more than one dinar each**."

This is the single most important historical source for the present study. It proves that the wind-catchers were omnipresent in late Fatimid and early Ayyubid times, which confirms the evidence in the astronomical texts. It does raise the question: when were the wind-catchers introduced in Cairo? Perhaps they were already in fashion in Fustat? Perhaps the answer is to be found in the astronomical tradition of Ibn Yūnus?

Notice first that al-Baghdādī says that Cairene houses are open toward the north. This was a tradition that was already a millennium old in Egypt.[129] Now al-Baghdādī does not say wind-catchers were to be found on almost every building, but rather on every house. They would be particularly useful on houses of several storeys, but clearly they are not exactly what is needed for large interior spaces such as mosques and madrasas. When we do find a *bādahanj* in a mosque or madrasa, it tends to be behind the *minbar* or pulpit. In mausolea we do not expect to find a *bādahanj*.

Unfortunately, perhaps, around 1970 I adopted the term "ventilator" from the translation of K. H. Zand *et al*. and used it in my subsequent writings on the Cairo wind-catchers. This partly accounts for the fact that the Cairo wind-catchers have slipped into oblivion on the internet, not least because a search on Google for "Cairo ventilator" tends to show up a myriad modern companies. Otherwise, it is not clear how this text could have remained unknown to, or at least ignored by all those who have written on historical architecture in Cairo.

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[129] Daniel, *Architectural orientations in the papyri* (2010), 95-113, esp. 103-104.

Ibn Faḍlallāh al-ʿUmarī on a bedtime story and a dream of riches

Shihāb al-Dīn Aḥmad ibn Yaḥyā known as Ibn Faḍlallāh al-ʿUmarī (1301-1349) was born in Damascus and became a distinguished author and administrator, serving the Sultan al-Nāṣir Muḥammad ibn Qalāwūn in the chancery in Cairo and Damascus. It is hardly surprising that we find a story about a *bādahanj* in his enormous encyclopaedic work, مسالك الابصار في ممالك الامصار, *Masālik al-abṣār fī mamālik al-amṣār*, *Routes towards insight into the empires of the capitals*, dealing with literature, history, geography, religion and law, politics and administration. A facsimile of the best available manuscripts for each section has been published in Frankfurt in 27 volumes (1988-89) with three index volumes (2001).[130]

The anecdote is attributed to someone unnamed – he was probably too embarrassed to let his name be circulated – from the *majlis* of the famous al-Qāḍī al-Fāḍil (1135-1200), counsellor and director of the chancellery of the Ayyubid ruler Ṣalāḥ al-Dīn al-Ayyūbī known as Saladin (1138-1193), when he became ruler of Egypt in 1172. This extract is taken from Dilli since I cannot access the original, and the translation is my own.[131]

> سكنت في مصر بدار عتيقة الاشرف وكانت لي زوجة كنت ابات انا واياها في بادهنج فاستيقظت ليلة فقالت رأيت في النوم قائلا يقول لي احفروا تحت الطيلسان الرخام الذي تحتكم وخذوا ما تجدونه من المال ... فقلت لها انا رجل فقير وهذا مجرد حلم ومنعتها منه بكل حيلة وما مضت الا ايام يسيرة حتى احرقت مصر فما شعرت الا وجماعة كبيرة من السودان قد هجموا الدار وقصدوا البادهنج فقلعوا الطيلسان

[130] For an introduction to the author see the article "Ibn Faḍlallāh" by Marius Canard. His work is listed as Ibn Faḍlallāh al-ʿUmarī, *Masālik al-abṣār ...,* 27 vols. plus 3 vols. of index; this publication was a major achievement of the Frankfurt Institute. The term *bādahanj* is not in the numerous indexes, but neither are the terms *ṭaylasān* and *samāwiyya*!

[131] The story is related in Dilli, "Cooling devices in the Abbasid era" (in Arabic), pp. 224-225, who gives Ibn Faḍlallāh, *Masālik al-abṣār ...,* XVIII, p. 309, as the source, but this is incorrect.

واستخرجوا من تحته سماوية نحاس يكون فيها قدر مائة الف دينار فاغمي علي ...

> "I used to live in Cairo in an old house ... (*al-ashraf*?) and I had a wife with whom I was sleeping in the *bādahanj*. She woke up one night and said: "I saw someone in my sleep who said to me: "You (and your husband) should dig under the trapezoidal (*ṭaylasān*) marble (slab) which is underneath (where) you (are sleeping) and take the money that you find there." " ... So I said to her: "I am a poor man, and this is nothing but a dream", and, by means of all (sorts of) stratagems, I prevented her from (doing anything about) it. Just a few days later, Cairo was burning, and I only noticed this when a large group of black men attacked the house and made straight for the *bādahanj*, pulled up the trapezoidal (slab) and took out from beneath it a container (*samāwiyya*, precise meaning obscure) of brass containing one hundred thousand dinars. (When I saw this,) I fainted."

We can imagine that he had problems discussing this with his wife when he recovered.

al-Ghuzūlī, the 14th-century author of an anthology of poems, including many on the *bādahanj* refers to al-Qāḍī al-Fāḍil as اكثر الناس ولوعا بالبادهنج, "the person who is most enamoured of all when it comes to *bādahanj*es", a charming epithet (see **Ch. 5**).

(To digress a little, the term *ṭaylasān* is of Persian origin and in Arabic refers to a trapezoidal shawl. It is also known from the astronomical sources, referring to an astronomical table that is trapezoidal in shape (with horizontal argument x running between two limits x_{min} and x_{max}, that is, $x_{min} < x < x_{max}$, and vertical argument y). Thus the earliest Islamic tables of time as a function of observed solar altitude h and maximum altitude H at midday, which varies between two limiting values at the winter and summer solstices, were called *ṭaylasān* tables. One enterprising mid-10th-century Baghdad astronomer ʿAlī ibn Amājūr went to the trouble of preparing two such tables, one based on an accurate formula for the

latitude of Baghdad and the other based on an approximate formula serving all reasonable latitudes.[132])

(Marco Polo visits Hormuz)

I repeat this section because it is so important. The famous Venetian traveller Marco Polo (1254-1324) noted the wind-catchers of Hormuz on the Gulf:[133]

> "Hormos – a great and noble city on the sea. ... ... There are a good many cities and towns belonging to Hormos, and the people are Saracens. The heat is tremendous, and on that account their houses are built with ventilators to catch the wind. The ventilators are placed on the side from which the wind comes, and they bring the wind down into the house to cool it. But for this the heat would be unbearable."

A note by his translator, the Scottish orientalist Sir Henry Yule (1820-1889) adds (my emphasis):

> "These ventilators are a kind of masonry windsail, known as Bádgír, or "wind-catchers", and in general use over Oman, Kerman, the province of Baghdad, Mekran, and Sind. A large and elaborate example, from (Xavier) Hommaire de Hell's work on Persia, is given in the cut above. Very

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[132] The first table of this kind to come to the attention of historians of science was studied in Goldstein, "Medieval table for reckoning time from solar altitude" (1963). (The values in this table were based on an approximate formula and unhappily 'adjusted' for a specific latitude.) All known Islamic tables for timekeeping of this type, a dozen in number, are discussed in King, *In Synchrony with the Heavens*, vol. 1 (2004), I: 60-65 & 66-68.

On the term *ṭaylasān* see Arazi, "Noms des vêtements d'après *al-Aḥādīṯ al-ḥisān fī faḍl al-ṭaylasān* d'al-Suyūṭī" (1976); Goldstein, "Medieval table", p. 61; and King, *Synchrony*, vol. 1 (2004), I: 41.

[133] Henry Yule, ed., *The Book of Ser Marco Polo*, (1871), vol. II, pp. 450-451. I thank Eckhard Neubauer for sending me this text. See also www.imdb.com/title/tt3441072/.

> particular accounts of these ventilators will be found in Piero della Valle, and in the embassy of Don Garcías de Silva Figueros.[134] **A somewhat different arrangement for the same purpose is in use in Cairo, and gives a very peculiar character to the city when seen from a moderate height.**"

This last remark shows singular insight and is the only known written reference from the 19th century to wind-catchers/towers in both Iran and Egypt.

The Cairo corpus of tables for astronomical timekeeping

As we shall see in **Ch. 13**, the astronomers in Cairo from the late 10th century onwards used an extensive corpus of tables for timekeeping by the sun and the regulation of the times of prayer. One of these was the table displaying the altitude of the sun throughout the year when it is in the direction of winter sunrise: the wind-catcher should be open toward the direction perpendicular to the direction of winter sunrise. Various astronomers contributed to the Cairo corpus over the centuries, starting with Ibn Yūnus in the late 10th century and continuing with al-Maqsī in the 13th and al-Bakhāniqī in the 14th. The last-mentioned could be understood as implying that Ibn Yūnus had included the table for the solar altitude in the azimuth of the wind-catcher in his corpus of tables of the solar azimuth for each degree of solar longitude and each degree of solar altitude.[135] The text might also be understood as saying that Ibn al-Rashīdī had added this table, but all of the other tables mentioned by al-Bakhāniqī are of functions tabulated by Ibn Yūnus in the *Ḥākimī Zīj*.

Ibn Ḥabīb

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[134] References as given: "*Della Val*. II 333-35; *Figueros*, Fr. Trans. 1667, p. 38; *Ramus*, I, 293 v.; *Macl. Kinnair*, p. 69".

[135] King, *In Synchrony with the Heavens*, vol. 1 (2004), p. 291.

Ḥasan ibn ʿUmar, known as Ibn Ḥabīb (1310-1377), was an eminent scholar and jurist born in Damascus, who visited Cairo and Alexandria and Jerusalem and Hebron and who spent time in Aleppo and Tripoli.[136] One of his works was a history of the Mamluk Sultan Qalāwūn and his sons entitled تذكرة النبيه في ايام المنصور وبنيه, *Tadhkirat al-nabīh fī ayyām al-Manṣūr wa-banīh*, *The Memoir of the intelligent concerning the times of (Sultan) al-Manṣūr (Qalāwūn) and his sons*.[137] In this, our author presents a detailed description of an enormous *qaysāriyya* or public building including shops,[138] mentioning features such as shops and doors. His description includes a remark:

... الباذاهنجات علو القيسارية المذكورة ...

" ... the *bādhāhanj*es at the top of the fore-mentioned *qaysāriyya* ... ."

This establishment was in Cairo, not in Damascus or Aleppo. There were *qaysāriyya*s in medieval Cairo, Damascus and Aleppo, as well as elsewhere. The Geniza documents mention such individual *qaysāriyya*s of wool-merchants and perfume-vendors in Fatimid times.[139]

The sorry tale of the Sultan al-Ashraf Shaʿbān

The Egyptian historian, Ibn Taghrībirdī (1410-1470), is famed for his annalistic survey of Mamluk history. What interests us here is a story about a tumultuous period related in the annals of the year 778 Hijra (1376/37),[140] here summarized. The Sultan al-Malik al-Ashraf Shaʿbān

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136 See the article "Ibn Ḥabib" by William J. Brinner (1924-2011).

137 Ibn Ḥabib, *Tadhkirat al-nabīh*, I, 345, already cited in King, "Astronomy and architecture" (1984), p. 128.

138 See the article "Ḳaysāriyya" in *Enc. Islam*, 2nd edn., by M. Streck.

139 Goitein, *Mediterranean Society*, I (1967), p. 194. I recall having read somewhere that the historian Ibn ʿAbd al-Ḥakam (d. 871) mentions yet others.

140 Adapted from Masarwa, "Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space" (2017), p. 115, who quotes

was found by the Mamluks hiding in a *bādahanj* dressed in woman's clothing:

فهرب السلطان واختفى في بادهنج البيت فطلعوا فوجدوه في البادهنج وعليه قماش النساء

> "The Sultan ran away and hid in the *bādahanj* of the house, and they came up and found him in the *bādahanj* wearing women's clothing … ."

al-Maqrīzī in *al-Sulūk* tells a similar story:[141]

... فاشارت الى بادهنج البيت فوجدوا السلطان قد لبس ثياب النساء واختفي فيه ...

> "(A woman) pointed to the *bādahanj* of the house and they found the Sultan who had put on women's clothing and had disappeared inside (the *bādahanj*)."

The Sultan was (re)dressed by his captors before being led away and he was strangled two days later.

The 1001 Nights

> "The Arabic language, ingenious in structure, at once rigid and sensitive, with its almost unlimited vocabulary to which all the tribes contributed their share of synonyms, being by theological definition a perfect instrument—for the Koran is held to be the very word of God—thus became a subject worthy of study; no occidental literature can in any way bear comparison with Arabic in the fields of grammar, rhetoric, lexicography and all branches of philology. When to all this is added the great literature of theology, law, philosophy, mathematics and science it becomes clear that the literary legacy of the Arabs is something rather more than the tales

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Ibn Taghrībirdī, *al-Nujūm al-ẓāhira*, Beirut, 1992, edn., XI, p. 61. Alev Masarwa kindly send me a copy of this text, which I later found was published in my 1984 study. On the life and demise of the Sultan see the article "Shaʿbān, II" by P. M. Holt in *Enc. Islam*, 2nd edn.

141 al-Maqrīzī, *al-Sulūk*, 3:1, p. 281, cited in King, "Architecture and astronomy" (1984), p. 128.

of the *Arabian Nights* which for most westerners represent the sum of Arab letters." A. J. Arberry, *British Orientalists* (1947), p. 9.

Franz Rosenthal has commented upon a colourful story from the *1001 Nights*,[142] whereby it should be remembered that some of these tales stem from 13th- and 14th-century Cairo:

> "(The) structure (of the *bādhanj*) inside the house comes to life in the story of the hunchback from the *Arabian Nights*. The hunchback's corpse is carried up to the roof and carefully let down the *bādhanj*, with the result that the owner of the house upon coming home saw a human figure standing in the corner of the wall underneath (inside the aperture for) the *bādhanj*. In reality, this must have been quite a difficult feat to accomplish, even though the size of the shaft was of generous dimensions. A verse tells us that the aperture was covered by a grating."

I have alas not been able to access the 1984 scholarly edition of the principal version of the Arabic text the Iraqi-American Arabist and Islamologist Muhsin Mahdi (1926-2007) for the present study, but the masterly 1839-42 edition is available online.[143] The relevant passage in the story of the 25th night, concerning a tailor, a hunchback, a Jew, a شاهد, *shāhid* (an appointment by the court of an expert witness somewhere between a notary public and a judiciary auxiliary who could sometimes act as a judge),[144] as well as a Christian, reads in Arabic with a slight Egyptian flavour (notably بادهنج, *bādahanj*, and بتاع, *bitā*ʿ, the possessive 'particle'), with my translation:

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142 Rosenthal, "Poetry and architecture", p. 6, quoting Macnaghten, I, pp. 202-203, ed. Habicht, II, pp. 127, 132 (Breslau 1825-43), trans. E. Littmann, I, 295-297 (Wiesbaden, 1953 < Leipzig 1921-28).

143 Macnaghten, ed., II, pp. 202-203 available on https://babel.hathitrust.org/c—*—gi/pt?id=hvd.32044108724824&view=1up&seq=5. In my rendition, two minor errors are corrected: لا نظره to لانظره لا سفله to لاسفله .

144 Following R. Peters, article "Shāhid" in *Enc. Islam*, 2nd edn. See also the more recent study Ron Shaham, *The Expert Witness in Islamic courts* (2010).

... واما الرجل والمرأة فادخلا (الاحدب) في البيت ووضعاه على سلم وذهبا فنزلت لانظره وانا في الظلام فعثرت فيه فوقع من فوق السلم لاسفله فمات من وقته فحملته انا وزوجتي ثم طلعنا به الى السطح ودار الشاهد هذا بجوار داري فارخحينا هذا الاحدب في الباهنج بتاع الشاهد وهو ميت فلما طلع الشاهد وجده في بيته فاعتقد انه حرامي فضربه بمطرقه فوقع على الارض فاعتقد انه قتله ...

" ... ... The man and his wife took the (very weak) hunchback into the house and they placed him on a ladder and went off. I came downstairs to see him but I was in the dark and I tripped over onto him. He fell from the top of the ladder to the bottom and died at the time (which God had ordained) for him (*min waqtih*). So with the help of my wife I carried him and took him up onto the roof. Now the house of this *shāhid* is next door to my house, so we lowered the hunchback into the ***bādahanj*** belonging to the *shāhid*, (said hunchback) being dead. When the *shāhid* went upstairs he found (the hunchback) in the house and thought that he was a thief, so he beat him with his hammer, and (the hunchback) fell down and (the *shāhid*) thought that he had killed him. ... "

This sad tale is a quotation serving as textual evidence (*shāhid*) that people in medieval Cairo did not need to have explained to them what a *bādahanj* was.

(In passing, we note another story in the *1001 Nights* which has attracted the attention of our colleagues, the late Spanish orientalist Juan Vernet Ginés (1923-2011) and, using a more recent (and first) critical edition by Muhsin Mahdi, the Dutch historian of Islamic mathematics and astronomy, Jan Hogendijk.[145] The Barber in one of the tales claims to be an expert in astrology, astronomy and mathematics, and supposedly used his astrolabe in order to check whether the moment was suitable for shaving a certain young man. (Of course, one cannot prepare a horoscope with only an astrolabe, which serves only the sun and stars; one also needs an ephemeris for the year in question to find the positions of the moon and

[145] Hogendijk, "A new look at the Barber's astrolabe in the *Arabian Nights*" (2007), replacing Juan Vernet Ginés, "La conjunción del barbero de Bagdad" (1966).

five naked-eye planets.[146]) Hogendijk succeeds in deriving a date of 1361 for the horoscope which underlies the passage of the Barber's astrolabe, which is important for dating at least part of the corpus of the *1001 Nights*.)

Anselm Adornes / Adorno

Anselm Adornes (born 1424 in Bruges into a Genoan mercantile family, murdered in 1483 in Scotland) was a merchant, patron, politician and diplomat. In 1470-71 he visited Palestine, and wrote a travelogue. His route took him, together with his eldest son, overland from Flanders to Genoa, thence by sea to Tunis and Alexandria. From there he took an indirect route overland to Jerusalem, visiting Cairo and St Catherine's Monastery in the Sinai. In Cairo he comments that the houses have a round hole in the roof (*trou ronde dans le toit par laquelle entre l'air frais avec la lumière*) through which fresh air and light come in.[147]

Felix Fabri

Felix Fabri (1441-1502) was a Swiss Dominican theologian who left vivid and detailed descriptions of his pilgrimages to Palestine during the period 1480-1483. His remarks on Cairo reflect his intellectual curiosity. I have used the 1975 French translation:[148]

> "Ces maisons n'ont pas le même style que les nôtres car elles ne sont pas construites pour se protéger de la pluie, de la neige ou du froid, phénomènes qui n'atteignent jamais l'Égypte, mais elles sont faites d'abord pour se protéger de l'ardeur du soleil, puis contre les incursions

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146 On the astrolabe see n. 514 below.

147 His travelogue is listed as Heers & de Groer, *Itinéraire d'Anselme Adorno en Terre Sainte (1471-1472)* (1978), esp. p. 1897.

148 *Felix Fabri – Voyage de 1483*, J. Masson, transl., Cairo 1975, II, p. 529 (fol. 103b).

des voleurs et des brigands. Le haut des maisons est donc généralement à ciel ouvert, mais cependant, du côté où le soleil brille, il y a une paroi qui monte vers le haut pour arrêter les rayons du soleil. Il est certain que si dans nos régions on ne craignait ni la pluie ni la neige, les constructions seraient d'un style différent, plus léger." / "These houses are not of the same style as ours because they are not constructed to protect from rain, snow and cold, phenomena that do not affect Egypt. Rather, they are made to protect from the heat of the sun, and also against thieves and robbers. The top of the houses is therefore generally (flat and) exposed to the open sky, apart from, on the the side where the sun shines, a (kind of) wall which goes up in order to stop the rays of the sun. It is certain that if in our part of the world one was not afraid of the rain or the snow, house construction would be of a different, lighter kind."

Felix Faber's remarks on our wind-catchers show that his Egyptian informants did not really explain the wind-catchers properly to him, but to our advantage. Instead of concentrating on the wind-scoop facing the northerly winds, they, and hence he, did not get beyond the rectangular back of the *bādahanj*, which he was told was for deflecting the rays of the sun and which indeed is at the centre of attention of the summer sun in Cairo. On the other hand, perhaps Father Felix has simply drawn our attention to the fact that the cover of a *bādahanj* does indeed deflect the heat of the sun at its most severe. No other historical source mentions this!

Fabri's mid-20th-century interpreter H. F. M. Prescott (1896-1972) wrote the following in her loose but very readable commentary to his travelogue:

"Even medieval European visitors considered, and even the inhabitants of Cairo admitted, that the multitudinous streets of the city – by pilgrim tradition they numbered 24,000 – were excessively narrow. On each side rose the tall houses, rarely of stone, commonly of mud brick in the lower storey, with those constructions of mud and wattle above which to Western visitors gave the buildings a look of poverty. This use of Nile mud might have been disastrous, Friar Felix thought, for, "if it happened to rain in Cairo for two days as it goes on sometimes for six with us, the whole city would melt like wax, and become a heap of mud ... ;" as, however, according to modern statistics the annual rainfall of Cairo is 1 inch, the danger was not great. Flat roofed, so that they looked, Friar Paul thought,

as if ruined and roofless, the oriental houses turned a blank face upon the street, and kept their comforts and their beauties for those who entered. Open upon the upper storeys to admit air, shaded from the sun by high wooden shutters or awnings from noon to sunset, **supplied with ingenious contrivances above the roof to induce into the house a current of air from the wind which blew for ten months in the year, the Cairene house was cool even in the summer heat,** and the flat roof which Paul Walther despised provided a place where members of the household slept at night."

Clearly our monk probably did not use an expression equivalent to "ingenious contrivances", although Latin could have handled that.

Miscellaneous sources identified by Paulina Lewicka

A remarkable study was published in 2010 by the Polish Arabist and Islamologist Paulina Lewicka. It dealt with food and eating habits in medieval Cairo, and presented a rich and colourful picture of Mamluk life. It is exceptionally well documented, so well, in fact, that it even presents information on wind-catchers that was previously unknown to me.[149] Indeed, it is a model orientalist study, offering a feast far beyond what one would expect from the title. The relevant section in the chapter on "The Dining-Room" reads:

"Instead of chimneys, most of the roofs of city houses had wind-catchers. These penthouse-like constructions, called *bādhahanj*, caught the cool breeze which, via a vertical ventilation shaft, air-conditioned the rooms below.[*] And so Cairenes ... ... ate and slept by the air shaft. The most privileged of the city's dwellers sometimes arranged the huge wind-catchers atop their villas so as to be able to hold banquets directly under the construction's sloping roof.[**] In the most modest apartments, on the other hand, the unsophisticated ventilation system consisted of windows and simple openings (*malqaf*) in the walls. Whatever the ventilator, the

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[149] Lewicka, *Food and Foodways of Medieval Cairenes: Aspects of Life in an Islamic Metropolis of the Eastern Mediterranean* (2011), esp. p. 382.

> meals were served and consumed where the air-conditioning let in a cool breeze.”

The asterisk marks a footnote (108) mentioning two works by S. D. Goitein which are discussed above under the Geniza documents; a work by Janusz Bylinski on the *waqf* documents relating to the substantial 15th-century houses along the “Darb Ibn al-Bābā” (which does not mention any *bādahanj*es); and the writings of Western travellers Anselme Adorno (1470) and Jean Coppin (1640). The double asterisk provides a reference (110) to writings on the Fatimid rulers by Ibn al-Ma’mūn and al-Maqrīzī (Ibn al-Ma’mūn, *Akhbār Miṣr*, p. 92; al-Maqrīzī, *Musawwadat al-Khiṭaṭ*, pp. 168, 217, 239, 316), the last of which I have not been able to pursue.

A question arises: is the term *malqaf* used in some medieval text? This would be a first! Perhaps the “simple openings in the walls” are the فتحة للريح, *fatḥa li’l-rīḥ,* which we have seen in some of the Geniza documents.

Leo Africanus (?)

Oleg V. Volkoff in his book celebrating the millenary of Cairo cited Leo Africanus and Prosper Alpino on the wind-catchers of the medieval city. Leo Africanus is one of the several names of a Berber Andalusī scholar, al-Ḥasan ibn Muḥammad al-Wazzān al-Fāsī. He visited Cairo around the time of the Ottoman conquest in 1517. His *Description of Africa*, documenting his voyage through Northern Africa, is now available on the internet. Volkoff quoted Leo Africanus as saying (my translation from the German version):[150]

> “During the summer the heat is so intense that it has become the custom to build a kind of high tower, open on the roof and possessing at its lower end a further opening which is connected to the living room: the wind blasts in at the top and blows through the tower towards the bottom.”

[150] Volkoff, *1000 Jahre Kairo*, p. 139.

Alexandre Lézine cites a similar text from an 1956 French translation:[151]

> " ... une haute cheminée qui a une ouverture au sommet et une autre à la base ... le vent entre par le haut, sort par le bas et amène un peu de fraîcheur." / " ... a tall chimney with an opening at the top and another at the bottom ... the wind enters at the top and comes out at the bottom, bringing (with it) a little freshness."

This quote is, however, not to be found in the 1600 version of Leo's *Description of Africa*.[152]

Edward Brown

The English traveller and former merchant Edward Brown visited Egypt during 1673-74. He wrote in detail on the winds in Cairo – see **Ch. 18** – but does not seem to have mentioned the wind-catchers. Brown wrote extensively on "science" in Egypt, but nothing on astronomy worth recording here.

The most recent French translation of his travels bears a simple sketch on the front cover of a semi-rural Egyptian scene with three wind-catchers on the roof of a village house.[153] This sketch is not in the 1739 edition of his travelogue (which has no images), not least because similar Egyptian scenes have been added to the reports of several other 15th-19th-century French and English travellers published by the Institut Français d'Archéologie orientale in Cairo: see **Pl. B9**.[154]

al-Khafājī

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[151] Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971), pp. 12-13, citing *Description de l'Afrique*, transl. (from the Italian), Alexis Epaulard, 1956, II, p. 493.

[152] Leo Africanus, *The History and description of Africa*, 1600 edn., 2010 reprint.

[153] Brown, *Travels and Adventures*, 1739 edn.

[154] http://www.ifao.egnet.net/publications/catalogue/Voyageurs/.

One of the few medieval Arab linguists who mentioned the word *bādahanj* was the Egyptian Shihāb al-Dīn al-Khafājī (1571-1659) who claimed in his شفاء الغليل في ما في كلام العرب من الدخيل, *Shifā' al-ghalīl fī mā fī kalām al-ʿArab min al-dakhīl*, on foreign loan-words in Arabic, that it was arabicized معرب, *muʿarrab* from بادخون, *bādkhūn* or بادگير, *bādgīr*, which is not the case.[155]

(The philologist Abu 'l-Faḍl al-Maydānī (d. 1124) in his السامي في الاسامي, *al-Sāmī fi 'l-asāmī*, an Arabic-Persian dictionary of common terms and words, mentions a host of names associated with houses and their constituents, but not the *bādahanj*. He was, however, functioning in Nishapur in N. Iran, where such devices may not have been known.[156])

Prospero Alpino

The physician and botanist Prospero Alpino (1553-1617) from the Republic of Venice spent three years in Cairo. He mentioned the wind-catchers there in his *De medicina aegyptiorum*, here in a modern French translation of the Latin followed by my English version:[157]

> "Cette ville est faite de très hautes maisons dont les toits s'étendent si largement sur les rues qu'ils cachent presque entièrement le ciel au-dessus d'elles et empèchent le soleil d'incommeder les passants (car, à toutes les heures du jour, l'ombre recouvre et protège les rues). De plus, on utilise de vastes conduits, semblables à de grandes trompes, et places a l'intérieur de toutes les maisons pour recevoir l'air froid. Ils s'élevent au milieu des

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155 On al-Khafājī see the article "al-Khafādjī" by F. Krenkow in *Enc. Islam*, 2nd edn. The reference is in de Goeje's edition of al-Muqaddasī, quoting al-Khafājī, *Shifā' al-ghalīl*, p. 47. See also n. 431 below.

156 On al-Maydānī see the article in *Enc. Islam*, 2nd edn., by R. Sellheim.

157 Alpin, *La médecine des égyptiens*, I, pp. 35-36 (R. de Fenoyl's translation of the original Latin). The illustration of a wind-catcher in Alpin's *de rerum aegyptiarum* (IV, pl. 1 on p. 35). See also Jerry Stannard, article "Alpini, Prospero" in *DSB*. Alpini's book is available at dfg-viewer.de.

> maisons, avec une ouverture d'environ six coudées; ils montent droit en l'air et atteignent le sommet, où ils se terminent en s'élargissant beaucoup plus, à la manière d'une panse de cloche. Par cette ouverture, tournée vers le nord, ils reçoivent la brise fraiche, qu'ils conduisent dans les parties basses de la maison : ainsi se trouvent refroidis le sous-sol et le rez-de-chaussée." / "This city is made up of very tall houses whose roofs extend so widely over the streets that they almost hide the sky above them and prevent the sun from being troublesome for passers-by (for at all times of day shade covers and protects the streets). In addition, they use vast ducts (*conduits*), similar to large trunks (*trompes*) and situated in the interiors of all the houses in order to receive the cold air. These ducts rise in the middle of the houses, with an opening of about six cubits; they go straight up in the air and reach the top, where they end in becoming much wider, like the body of a bell. By means of this aperture, turned toward the north, they receive the fresh breeze, which they drive into the lower parts of the house. In this way, the floor and the ground-floor are cooled."

Alpino's illustration is a somewhat naïve but quite charming representation of the tubular inside of a *bādahanj* and is shown in **Pl. B7**. Since there was a tendency amongst European artists visiting Cairo to represent the houses of the city without any wind-catchers at all – see below on some 15th- and 16th-century European drawings – Alpino's illustration is proof that he at least took the *bādahanj*es seriously, though see below. He also mentioned them in his *Histoire naturelle de l'Égypte*, 1581-84, when discussing the imposing and sumptuous houses in the City:

> "J'ajoute un détail. Vers le centre de chaque maison il y a un très large conduit, fait de bois ou d'un autre matériau, complètement creux et ouvert; il va presque du sol de la maison jusqu'au toit; il s'évase comme une cloche à grande panse; sa partie supérieure est ouverte en direction du nord; par cette ouverture, le vent froid venant du nord entre et il descend pour rafraîchir toute la maison. De même que, dans les pays qui sont froids à cause de la température particulièrement basse de l'air, on utilise des hypocaustes chauds pour préserver les hommes du froid, de même, dans les pays où la chaleur est très forte on se sert des conduits de ce genre pour se préserver de la chaleur." / "I add a detail. Toward the middle of each house there is a very large air-duct, made of wood or of some other material, completely hollow and open at each end. It goes almost from the

> floor of the house up to the roof, and its upper part is open in the direction of north. Though this aperture the cold wind coming from the north enters and descends to freshen the whole house. In the same way that in lands which are cold because of the particularly low temperature of the air, people use hot stoves to preserve themselves from the cold, in lands where the heat is very considerable, people use air-ducts of this kind to preserve themselves from the heat."

This is the only reference in any text that the inside of the *bādahanj* might be lined with wood or some other material.

This section of Alpino's treatise was translated from the original Latin by Robert Daniel – see **Ch. 10**.[158] Although Alpino resided in Egypt in the 1580s, his *Historia Ægypti naturalis* was not published until 1735 in Leiden. I concur with Daniel that the diagram reproduced in **Pl. B7** is a probably a distortion of what Alpino intended; it certainly bears no resemblance to any Cairo wind-shaft.

Jean Coppin

Jean Coppin (*ca*. 1615 - *ca*. 1690) was a French traveller and professional soldier, who tried to enthuse the French people for a crusade against the Ottoman Empire. Coppin travelled to Egypt in 1638, where he stayed for eighteen months. He returned to France with a cargo of antiquities for sale but was raided by Mallorcan pirates. A second voyage was undertaken in 1643–1646, where he was in the Levant, visiting Tunis and Syria, and became consul at Damietta in 1644. He returned to Europe, with firm plans for a crusade, but the authorities were not at all interested. Subsequently, he decided to publish his work, hoping to find the public more willing to listen to his plans.

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[158] Daniel, *Architectural orientation in the papyri* (2010), pp. 138 & 142 & 208-209.

In his *Voyages en Égypte* Coppin has a chapter on the houses of "big and little people" (*des maisons des grands & et du menu peuple*) and states:[159]

> "Le corps de chaque maison a deux étages de chambres, mais la salle qui est toujours au milieu du bâtiment n'en a qu'un seul, & occupe depuis le bas jusqu'au couvert, où l'on a coûtume de rapporter un pied de terre pour arrester la violence des rayons du Soleil; c'est l'usage de l'Égypte qu'il reste à ce couvert une ouverture de cinq ou six pieds en quarré qui donne directement au milieu de la salle; on la ferme d'un rideau pendant le jour, mais on l'oste la nuit afin que la fraicheur puisse entrer par ce passage. Cette ouverture aux maisons des riches a un petit lambris soutenu des pilliers avec une balustrade à l'entour; en d'autres il n'y a seulement que la balustrade sans lambris, et les habitations des pauvres sans avoir ni l'un ni l'autre, ont simplement l'ouverture, car il ne s'en voit que très peu sans cela." / "The inside of each house has two storeys of rooms, but the room that is always at the middle of the building only has one storey from below up to the 'cover' (*couvert*), where it is customary to put a frame (?) covered with soil (?? *pied de terre*) to stop the violence of the rays of the sun. It is the custom in Egypt to have by this 'cover' an opening of five or six feet square which looks down to middle of the room. People close the opening with a curtain during the day but open it during the night so that the freshness can come in through this passage. This opening on the houses of the rich has a small cover (*lambris*) supported by poles with a balustrade around it; on others there is only the balustrade without a cover. The dwellings of the poor, without having one or the other, have simply the opening, and very few houses are to be seen without one."

The precise meanings of some of the terms used by Coppin – *couvert*, *pied de terre*, *lambris* – are unclear to me in this context. Clearly the *bādahanj* is above the middle of the house rather than alongside a wall. Again this

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159 Jean Coppin, *Voyages en Egypte*, 1971 edn., pp. 78-80 (*ex* 196-197), mentioned in passing in Lewicka, *Food and Foodways of Medieval Cairenes* (2011), esp. p. 382, n. 108.

is the only text known to me which mentions closing the very large bottom aperture with a curtain during the day, apart from the treatise of al-Tanūkhī (**Ch. 4**).[160]

Coppin next relates a story about a Frenchman he knew who was involved in an unspecified intrigue and who one night wanted to meet with a certain person and, wishing to go to his rendez-vous *incognito*, wrapped himself in a white cloth and made his way across some roofs. However, the hapless fellow fell down one of these ventilation-shafts (*il tomba par une de ces ouvertures*), waking the owners of the house out of a deep sleep and ended up as their prisoner. ... . This sounds like a good theme for a new film starring Kad Merad! And folk falling into ventilation shafts is not unheard of today.[161]

George Sandys

George Sandys (1578-1644) was a British poet and politician. After studying at Oxford he became colonial treasurer for agriculture and industry of the Virginia Company. In his lifetime he was much admired as a translator of Latin poetry. Sandys travelled in the East in the years 1610-1611, starting out from France. He sailed from Venice to Constantinople, thence to Egypt, and thereafter visited Mount Sinai and Palestine. Sandys' chronicle is the first detailed and polished travel account, with well-documented information from ancient sources cited in marginal notes. As such, it marks the transition from travel literature of the 16th century to

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160 See n. 53 above.

161 HME staff, "Man plummets down hotel ventilation shaft", *Hotelier Middle East* 27.09.2010, at www.hoteliermiddleeast.com/9562-man-plummets-down-hotel-ventilation-shaft.

that of the 17th. It is also representative of those travel narratives that oscillate between geography, history and autobiographical travelogue.[162]

Sandys' 1615 publication contains a brief mention of the *bādahanj*, obscure enough to confuse anybody who had not seen one.[163]

> "Les maisons sont plus belles à l'extérieur que commodes à l'intérieur étant mal agencées avec des couloirs enchevêtrés. Cependant les toits se trouvent haut placés et le dernier étage est légèrement entr'ouvert en son milieu pour laisser entrer l'air frais ... ." / The houses are more beautiful on the outside than they are comfortable inside, being badly laid out with tangled corridors. Meanwhile the roofs are high and the final storey is lightly open at the middle in order to let in fresh air."

A little more information would have been useful. Alas, of Sandys' paintings none seems to feature Cairo.

Antonius Gonzales

The Spanish priest Antonius Gonzales (1604-1683) visited Egypt in 1665-66 and wrote a book about his experiences. He has left us an engraving of a *bādahanj* which we discuss in **Ch. 6**.

Evliya Chelebi

The 17th-century Turkish scholar and traveller Evliya Chelebi,[164] in his monumental 10-volume description of places in the Ottoman Empire entitled سياحتنامه, *Seyāḥatnāme*, made the following observations in

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162 This paragraph is adapted from Ioli Vingopoulou at https://eng.travelogu—*––es.gr/collection.php?view=100.

163 Sandys, *Relation of a Journey begun in 1610* (1615). I have used the more readily available modern French version listed as George Sandys, *Voyage en Égypte 1611*, where this extract features on p. 125 (*ex* p. 93).

164 For a brief introduction see the article "Evliya Çelebi" on Wikipedia.

Ottoman Turkish about the wind-catchers of Cairo during his lengthy sojourn there around 1670-80:

> "The lower city (*i.e.*, below the citadel) has buildings pressed up against one another, so the roads are narrow and dark. For this reason, all the houses overlook one another and **every room has a ventilator (*bādgīr*) on the roof to catch the wind, like a sail**. These ventilators are said to go back to Ebu Ali Sina. They catch all the winds of Cairo through the science of alchemy. Everyone according to his means buys these wind-presses (معصره, *maʿṣara*), which were invented by Ebu Ali Sina, for one gold piece each. They put the wind-presses on their roofs, the wind enters them, and the people of Cairo can breathe. These ventilators are said to go back to Ebu Ali Sina, and because of them the air in the lower city is not uniform, but changes ten times a day."

Whatever the problems of these remarks, not least the spurious association of the invention of the wind-catchers with the great Iranian philosopher and medic Abū ʿAlī Ibn Sīnā (980-1037),[165] but also the terminology, it is clear that Evliya was impressed by the many wind-catchers he saw in Cairo and also by their efficacy. He calls them by the name that was used for wind-towers in Iran. His curious mention of Ibn Sīnā in his discussion of the wind-catchers he saw in Cairo is explained by the fact that Ibn Sīnā (see above) did indeed mention the *bādahanj*, advocating its use in providing both fresh air and coolness; invent it, however, he did not.

The same passage, and more of Evliya's text dealing with medicine in Egypt, has been translated by Gary Leiser and the late American historian of Islamic medicine, Michael Dols).[166] Gary Leiser is an American

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165 Translated from MS Istanbul Üniversitesi Türkce Yazmalari 5973, fol. 241a-241b, by Robert Dankoff, who kindly brought this reference to my attention, and by my friend, Dimitri Gutas, who is the author of *Orientations of Avicenna's philosophy* (2014). See the commentary in King, *In Synchrony with the Heavens*, VIIb, p. 782, n. 6 (not in the 1984 paper "Architecture & astronomy").

166 Leiser & Dols, "Evliyā Chelebi's description of medicine in 17th-century Egypt" (1987), esp. p. 201. The presence of footnotes is indicated by asterisks.

historian of the Near East in the widest possible sense, with interests ranging from Late Antiquity to the Byzantine and the Islamic worlds, his latest book (2016) being on prostitution in the Eastern Mediterranean world from Late Antiquity to the medieval period. Michael Dols (1942-1989), whom I am happy and grateful to have known personally, is perhaps best remembered for his groundbreaking 1977 book *The Black Death in the Middle East*. Their translation reads:

> "First of all, the water of Cairo, the navel of the world and coveted object of kings, is the Nile. There is no other (source) of water. It has been praised in various accounts and descriptions above.* The people of Cairo never suffer from malaria.* As mentioned above in particular,* the climate of the inner Citadel is refreshing. The lower city is on a plain, so that it has less wind.* There are, however, many buildings. And there are gardens, vineyards, and orchards; numerous pools at every corner;* and wall fountains* in courtyards, all with flowing water. The songs of nightingales and the voices of (other) sweet-singing birds (can) revive a man. These pleasures are not found at the upper Citadel. Nevertheless, the weather is excellent (in the upper Citadel). If someone in the lower city becomes ill, they take him to the upper Citadel. The uppeelr Citadel is (virtually) a hospital for the lower city.
>
> "Because the lower city has multi-storey buildings, the streets are narrow and it is dark. All the houses tower over each other (on the streets). **In order to capture some breeze, each house has on its roof an opening like a sail for ventilation**.* (The people are able) to catch the breeze with it. They say these vents remain from the time of Abū ʿAlī (Ibn) Sīnā.* He "scientifically" captured the winds of Cairo. Everyone, according to his means, paid Abū ʿAlī (Ibn) Sīnā one piece of gold for one *masara** of wind and stored them on the roof.* [L&D: Here Evliya is being facetious.] From there, the wind entered (the houses), and the people of Cairo breathed it. They say that these vents originated with Abū ʿAlī (Ibn) Sīnā. The weather of the lower city, therefore, is variable. In one day there can be ten breezes.

> The good breeze blows from the --- [LACUNA!].* In Anatolia they call it --- [LACUNA!].* ... ."

Here we see how different Western scholars render the same Oriental text with slight variations. We also see how historical texts have lacunae or unintelligible phrases at places where modern investigators seek significant information. **What is important for us is that Evliya in the 17th century wrote that all houses in the lower city have a wind-catcher. ʿAbd al-Laṭīf al-Baghdādī said the same thing around the year 1200.**

ʿAlī Bey

ʿAlī Bey ibn ʿUthmān al-ʿAbbāsī was the pseudonym of the Spanish traveller Domingo Badia y Leblich, born 1766 in Spain, died 1818 in Syria. He travelled extensively in the Muslim world and wrote an appropriately extensive account in French of his impressions. The author of the 1816 English version wrote that "the name and pretensions assumed by Ali Bey may induce some to be inquisitive as to his personal reality," a statement that is still valid 200 years later. On Google he becomes a "Spanish explorer, and spy". On the houses of Cairo he wrote[167]

> "It is said that the summer is very hot in Cairo; but the heat ought to be very temperate, on account of the form of the streets and houses. The roofs of the rooms have very large apertures, to produce a current of air."

Not quite accurate, but certainly on the right track.

Edward W. Lane

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[167] Article in Enc. Islam, 2nd edn., "ʿAlī Bey" (I, p. 392a) by the editors. For this quote see *Travels of Ali Bey in Morocco, Tripoli, Cyprus, Egypt, Arabia, Syria, and Turkey between the years 1803 and 1807* (1816), II, p. 15.

The English orientalist Edward W. Lane (1801-1876), in his book *The Manners and customs of the Modern Egyptians* first published in 1836, observed:[168]

> "Many houses (in Cairo) have, at the top, a sloping shed of boards, called a *malkaf*, directed towards the north or northwest, to convey to a *fes-hah* or *fesahah* (an open apartment) below the cool breezes which generally blow from these quarters."

This seems to be the earliest use of the term *malqaf* for the medieval Arabic *bādahanj* – see further **Ch. 11**: "What's in a name?"

Lane's description of Cairo itself was not included in *The Modern Egyptians*. His nephew, Stanley Lane-Poole, who as a child had lived with his uncle in Cairo, edited it as *Cairo fifty years ago* in 1896. In this, there is not a word about *malqaf*s.[169]

In his voluminous *Description of Egypt*, published for the first time in 2000 by Jason Thompson, Lane does not even mention the Cairo *malkaf*s, using the word only once in a note about Ancient Egyptian houses.[170] He also appears to have been totally innocent of the vibrant and colourful tradition of astronomy which had flourished in Cairo in earlier centuries – see **Part Ib**. Lane did not like the Napoleonic *Description de l'Égypte* and thought it was very inaccurate in some aspects; he wanted his *Description* to be more accurate than the work of his predecessors.[171] On science and technology he failed miserably. On wind-catchers he did better in *Manners and Customs*. His somewhat uninspired pictures in the *Description* are nevertheless useful for our present purposes: see **Pls. F10-**

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168 Lane, *The Manners and customs of the Modern Egyptians* (1895), p. 29, quoted in King, "Architecture & astronomy", p. 98 / *Synchrony*, VIIb: 782.

169 Lane-Poole, ed., *Edward W. Lane: Cairo fifty years ago* (1896).

170 Lane, *Description of Egypt*, p. 337, n. 7.

171 Thompson, "Lane's *Description of Egypt*" (1996), p. 567.

12. This mild criticism comes from someone who has been using Lane's *Arabic-English Lexicon* with confidence and gratitude for some 50 years.

Aḥmad Taymūr Pāshā

The Egyptian writer Aḥmad Taymūr Pāshā (1871-1930) was an impressive man of letters. He was widely read and knew Persian and Turkish. He authored books on eminent engineers, surveys of scholars, colloquial proverbs, traces of the Prophet, love amongst the Arabs, and games amongst the Arabs. He also used his inherited wealth to acquire books and manuscripts. Of the latter he bequeathed some 20,000 to the Egyptian National Library. For me in the 1970s it was a privilege to catalogue those manuscripts from his collection dealing with astronomy and mathematics.

In addition to the above-mentioned books he authored an enormous Arabic dictionary of Egyptian Colloquial Arabic in several volumes, معجم تيمور الكبير في الالفاظ العامة, *Muʿjam Taymūr al-kabīr fi 'l-alfāẓ al-ʿāmma*, *Taymūr's large dictionary of colloquial expressions*.[172] Under the term ملقف, *malqaf*, the dictionary gives, in addition to a correct etymology of the term *bādahanj*, all manner of references for that term in the medieval literature. Fortunately for me, the references are mainly – but not all – to poetry within the two anthologies of al-Ghuzūlī and Ibn Abī Ḥajala. I leave it to future researchers to investigate whether any of the other references are of any historical significance. The Arabic text of Taymūr's entry is reproduced in **Pl. N15** in **Part II**.

Other sources

I do not doubt that there are more references to the Cairo wind-catchers in the vast literature by foreign travellers in Egypt. I write this in spite of the

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172 Taymūr, *al-Muʿjam al-kabīr* (2002 edn.), V, p. 393. I owe this reference to the kindness of Alev Masarwa.

fact that such literature does not always report what some of us think are important items worthy of at least a mention. I think of the 200-page corpus of tables for astronomical timekeeping and regulating the times of prayer, used in Cairo for close to a millennium and not mentioned by anybody. In the encyclopaedia of the sciences, *Irshād al-qāṣid*, compiled in Cairo by Ibn al-Akfānī in the 14th century, the section on astronomical timekeeping mentions the work on instruments by al-Marrākushī but fails to mention the corpus of tables used for timekeeping in Cairo.[173] Even in a modern book devoted to timekeeping in the Muslim world, the entire gamut of tables for timekeeping and regulating the times of prayer from Morocco to Central Asia to the Yemen for centuries is dismissed in half a sentence.[174]

There are numerous Egyptian sources that have not been fully exploited for what they may contain in the way of information on and/or anecdotes about the Cairo wind-catchers. I think of medieval encyclopaedias such as the 27-volume *opus magnum* of Ibn Faḍlallāh al-ʿUmarī (1301-1349), the

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173 On Ibn al-Akfānī see J. J. Witkam, ed., *De egyptische arts Ibn al-Akfānī ...* (1989). For his remarks on astronomical timekeeping see King, "On the role of the muezzin and *muwaqqit* in medieval Islamic society" (1996), pp. 303-304 / *Synchrony*, V: 648-649.

174 The late Barbara Stowasser in her book *Perceptions of time in the Islamic world* (2014) (using a pdf without pagination):

> "This large crowd of accomplished scientists [the *muwaqqit*s] left a rich legacy of sophisticated tables for time reckoning and regulation of prayer times."

بس كدا ! . Stowasser devotes considerable space to the astrolabe, but it was tables not astrolabes that were used in medieval Islamic civilization, at least in the major cities, for timekeeping and regulating the prayer-times. The problem is: astrolabes are sexy, tables are not.

In 1971 I gave a lecture at the American University of Beirut entitled "Medieval Islamic Prayer Tables". A few minutes after I started, a young lady in the front row got up and walked out. I later learned that she was interested in historical Near Eastern furniture.

description of the topography and history of Egypt by al-Maqrīzī (1364-1442), or the later history of Ḥasan al-Jabartī (1753-1825) and the geography of ʿAlī Pāshā Mubārak (1823-1893).[175] Some 318 volumes of reprints of text and studies on Islamic geography have been published in Frankfurt. And some 79 volumes of accounts of Western travellers to the Near East. Some 114 volumes of reprints of studies mainly from the 19th and early 20th centuries are available on the history of Islamic mathematics and astronomy?[176] So perhaps we have just scratched the surface, although what can we do about it? Inevitably, the series are not to be found in the world's most serious libraries, and most of the volumes in the different series are out of print.

This having been said, in al-Jabartī's account of the French occupation, there is not a word about wind-catchers to be found, and this in spite of descriptions of the French "firing ... from the tops of houses and windows with bullets", and "(Egyptian) women ... wail(ing) from the windows".[177]

There is another category of textual source that we should consider, namely, endowment deeds of religious establishments, and to these we now turn.

The wind-catchers in *waqf* documents for Cairene religious architecture

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[175] For these two scholars the sites https://en.wikipedia.org/wiki/Abd_al-Rahman_al-Jabarti & https://en.wikipedia.org/wiki/Ali_Pasha_Mubarak are recommended for a start. al-Jabartī's history has been translated into English by a series of scholars and edited by Thomas Philipp and Moshe Perlman, with an important index and guide to the text by Guido Schwald, published in 1994. See the brief account of the state of publication on Arabic historical works dealing with Egypt in Nelly Hanna's 1996 review this work.

[176] Information accessible *via* igaiw.de.

[177] See Moreh (& Tignor), *Al-Jabartī's Chronicle of the French occupation* (2004 edn.), pp. 22 & 37.

> “Literally thousands of *waqfiyya*s dating to the Mamluk period are preserved in the Egyptian Ministry of Waqfs and National Library in Cairo as well as in court archives in Cairo, Damascus, and Aleppo. The vast majority of these remain untouched by historical scholarship.” Khaled Ahmad Alhamzeh, *Late Mamluk Patronage: Qanṣūh al-Ghūrī’s* waqf *and his foundations in Cairo* (1993), p. 28.

A *waqf* is a religious endowment associated with a specific building to be used for religious, educational or charitable causes. The documents describing the buildings, their functions and their staff, are called *waqfiyya*s in medieval Arabic.

The first scholar to have drawn attention to the importance of *waqfiyya*s for the study of historical Islamic architecture appears to have been the Israeli orientalist of Ukrainian origin, Leon A. Mayer (1895-1959). Mayer was author of the splendid and most useful series *Islamic Architects / Astrolabists / Woodcarvers and their works* (1956-58). He published a very important *waqfiyya* in 1938 – see below.[178] Then in 1976 the British orientalist J. Michael Rogers, a brilliant linguist as well as art historian, stressed the importance of the entire genre of *waqfiyya*s.[179]

The late German historian, Islamicist and Mamluk specialist Ulrich Haarmann (1942-1999), in summarizing the contents of a typical *waqf* document,[180] mentioned:

> “the purpose of the pious foundation and the functions of the individual elements of the building are summarily described: pulpits, *īwān*s, minarets, courtyards, windows, cells, fountains, cisterns, store-rooms, kitchens and even shops that could be rented out to provide additional

[178] Mayer, *The Building of Qaytbay as described in his endowment deed* (1938).

[179] Rogers, “Waqfiyyas and waqf-registers: new primary sources for Islamic architecture” (1976/1977).

[180] Haarmann, “Mamluk endowment deeds” (1980), p. 34.

regular funds are mentioned here. ... ”

To the architectural details mentioned here, one can add the occasional specific mention of a *bādahanj.* Thus, for example, the *waqfiyya* associated with the Khānqāh or ṣūfī convent of Baybars al-Jāshankir, dating from 1306-1310, mentions four wind-catchers (*bā<u>dh</u>ahanj*) (Jaubert #24).[181] The relevant extracts read in Leonor Fernandes' translation (Arabic text not available):

> “ ... In the back of the larger *īwān* is a *miḥrāb*. It is flanked by two vaulted wings (*janāḥayn*) built in limestone. In the back of each of them is a wind-catcher (*bā<u>dh</u>āhanj*). The second *īwān* has three slightly raised step-like platforms (*marātib*). In one of the recesses is a wind-catcher; all of this is built in limestone and arched. ... ... (One of two *majlis*es) also has a large *īwān*, older in construction, with a large wind-catcher in its back wall. ... .”

In the *waqfiyya* of the Madrasa of Sultan Barqūq (1384-86) there is a curious reference to a *malqaf* with four square doors.[182] This was kindly brought to my attention in Cairo in the mid-1970s by my friend and colleague Felicitas Jaritz, then of the Swiss Institute. This is not necessarily a “Windfang” or wind-catcher as it was rendered in her joint 1982 publication with Saleh Mostafa Lamei, but what it is or was, is open to discussion. The relevant extract reads:

> ... اوان مسقف نقيا مدهون كافوريا بصدره شباك حديد كبير مطل على الدركاة المقدم ذكرها امامه دور قاعة منصوبة بالغرد (؟) بملقف بها اربعة ابواب كل منها مربع ...

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[181] Fernandes, “The foundation of Baybars al-Jashankir” (1987), is an imposing study of a historical building in the light of a contemporaneous text describing it. The extracts are on p. 24, with further discussion on p. 28, and are cited in Jaubert, “Capteurs de vents” (1995), p. 191 (*ad* #24).

[182] Lamei & Jaritz, *Madrasa, ḫānqāh und mausoleum des Barqūq in Kairo* (1982). See already King, “Architecture and astronomy” (1984), p. 128, for this extract, and p. 103, n. 22, on the term *malqaf*.

Wind-catchers also feature in the *waqfiyya*s of the building complex, or madrasa and mausoleum, of Sultan Qā'it Bāy (reg. 1468-1496), so diligently edited by L. A. Mayer already in 1938 (my translation):[183]

> ... بصدر الايوان مرتبة بواجهتها قنطرة معقودة يعلوها بيت الباذاهنج ... ... الايوان الكبير فانه على يسرة الداخل به خرستانان وسدلة بها ايضا خرستانان يعلوها باذاهنج ...
>
> "At the centre of the *īwān* is a step-like platform at the front of which is an arched vault and above this is the encasement for a wind-catcher ... . The large *īwān* is on the left of the person entering it. There are two *kharastān*s (?) and a recess (سدلة, *sidilla* / *sadla* ?) which also has two *kharastān*s and above (the recess) is a wind-catcher (*bādhāhanj*). ... ."

Mona Zakariya has studied the *waqfiyya*s of two 15th-century palaces, namely, those of the *amīr* Ghānim (1479) and Shihāb al-Dīn (1484) (Jaubert, #33 & #35), which also contain references to *bādahanj*es. In the first there is mention of a step-like platform (*martaba*) above which is a *bādhāhanj*.[184]

The Polish Arabist Janusz Bylinski has investigated the *waqf* documents relating to the 15th-century houses along the "Darb Ibn al-Bābā", some of which overlooked the lake called بركة الفيل, *Birkat al-Fīl*, "Elephant Lake".[185] This enabled him to make a brilliant reconstruction of the make-

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183 Mayer, *The Building of Qaytbay as described in his endowment deed* (1938), pp. 40, l. 14, and 43, ll. 1-2. Not mentioned in Jaubert, "Capteurs de vents" (1995).

I take the reading *sidilla* meaning "recess" for *s-d-l-h* from Janusz Bylinski, "Darb ibn al-Baba: A quarter in Mamluk Cairo in the light of waqf documents" (1994), p. 215. Elsewhere we find *sadla* – see Ismail, "Historical introduction" (2005), p. 119.

184 Zakariya, *Deux palais du Caire médiéval – waqfs et architecture* (1983), pp. 60 & 94 and 18 & 131; and Jaubert, "Capteurs de vents" (1995), pp. 194-195 (#33 and #35).

185 Possibly it bore this name because it was shaped like the head of an elephant with a very long trunk. The French called it "Lac de l'Hippotame". Recall that

up of these houses, and also of the identities of their inhabitants. All sorts of details are mentioned in the *waqf*s, but, alas for our purposes, *bādahanj*es are not amongst them. Bylinski presents a painting by Robert Hay (*ca*. 1840), as well as an early photograph, of houses alongside the Birkat al-Fīl, none equipped with *bādahanj*es. On the other hand, a 19th-century picture of the lake by one M(onsieur) Freedman shows two substantial *bādahanjes* on two houses overlooking the lake and none on several other houses – **Pl. D19**.[186] We should recall that the houses described in the *waqf*s predate by 300 years the houses still visible to 19th-century painters. The lake was filled in towards the end of that century to give way to the fashionable villas of the Ḥilmiyya quarter.[187]

The German Arabist Lucian Reinfandt has published the *waqfiyya*s of the buildings belonging to the 15th-century Mamluk Sultans al-Ashraf Īnāl and al-Mu'ayyad Aḥmad ibn Īnāl. These included all manner of buildings including market-halls living-quarters, shops, bakeries and public baths, even cattle-stalls. In one of these documents, dated 1460 and describing a building complex in Fustat, there is a reference to a *bādahanj*.[188] The text reads (my translation from the German):

> "Also belonging (to this building) is a smaller hall (*qāʿa*) with an *īwān* and courtyard. Further, there is an area for women, living rooms, landings, accessible roofs, a *bādahanj*, as well as furnishings and equipment."

Khartoum, in Arabic الخرطوم, *al-Kharṭūm*, "elephant's trunk", is so called because the confluence of the White and the Blue Niles resembled that, so it was thought.

186 Chantal Bouchon, "Le Caire d'Adalbert de Beaumont" (2013), p. 257, from Adalbert de Beaumont, *Voyages dans les cinq parties du monde*, Paris, 1846, p. 200.

187 For more details, see Bylinski, "Darb ibn al-Baba: A Quarter in Mamluk Cairo in the light of Waqf Documents," (1994), p. 222.

188 Lucian Reinfandt, *Mamlukische Sultansstiftungen des 9./15. Jahrhunderts* (2003), p. 335.

Layla Ibrahim's 1978 study "Middle-class living units in Mamluk Cairo" is based on six *waqf* documents.[189] The word *bādahanj* apparently but not necessarily does not occur in these.

The late American historian Olivia Remie Constable (1961-2014) in her fascinating book on "housing the stranger" in the Mediterranean world for over a millennium,[190] mentioned *waqfiyya*s for *funduq*s, or lodgings for strangers:

> "Endowment documents provide some idea of the physical elements within *funduq*s, and these show little change from earlier periods. They pay careful attention to the structure of buildings – stairs, corridors, roofs, doors, storerooms, chambers, benches, shops – and to provisions for light and air (windows, sky-lights), water (wells, cisterns), heating and cooking (ovens, chimneys), and sanitation (gutters, pipes, and latrines). In some cases, they mention decorative elements such as marble, tiles, and furnishings."

I think we can be confident that the "sky-lights" for "air" referred to are *bādahanj*es, not least because we have other evidence of *bādahanj*es in *qaysariyya*s in the writings of Ibn Ḥabīb (see above).

A remarkable and brilliant 1993 doctoral dissertation by the Jordanian historian of Islamic art, Khaled Ahmad Alhamzeh, is distinguished by its academic excellence, its historical accuracy and attention to detail, and its extensive bibliography. Add to that its readability! The author presents the Arabic text, with English translation and commentary, of a substantial *waqfiyya* for a complex of monuments erected by Sultan Qanṣūh al-Ghūrī

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189 Ibrahim, "Middle-class living units in Mamluk Cairo: Architecture and terminology" (1978).

190 Constable, *Housing the Stranger in the Mediterranean World* (2003), p. 241, and n. 18, on the sources (including Denoix' s study on Khān al-Khalīlī and the same Ibn Ḥabīb, *Tadhkirat al-nabīh*, II, pp. 427-448).

(*reg*. 1501-17).[191] (This is one out of 290 *waqfiyya*s associated with the Sultan that survive in the Egyptian National Library.) Every possible architectural detail is mentioned, as well as the duties and salaries of the staff (including the mosque-astronomers), except, inevitably, the *bādahanj*es. Yet the parts of the complex survive and a serious ventilation shaft by a reception hall (*qāʿa*) is shown on the plan of Maury, Revault and Zakariya, which is reproduced by Alhamzeh.[192] So *waqfiyya*s do not hold all the secrets.

It is beyond the scope of the present endeavour to pursue other mentions of *bādahanj*es in medieval *waqfiyya*s. Suffice it to say that Olivier Jaubert has already done that. Somewhere I have seen a lengthy list of Egyptian *waqfiyya*s relating to medieval architecture, but I forget where.[193]

The *waqfiyya*s can be of interest to historians for all sorts of other reasons. For example, some Mamluk *waqfiyya*s prescribe for the institution in question the number of staff who are involved in astronomy and the regulation of the astronomically-defined times of Muslim prayer, in addition to the muezzins. This information has been used in an attempt to document the history of the mosque astronomers called *muwaqqit*s and the muezzins who announced the calls to prayer.[194] Only one *waqf* document is known to me which specifies the actual purpose of the astronomical associations of the edifice: the roof of the Qurqumās funerary complex

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191 Khaled Ahmad Alhamzeh, *Late Mamluk Patronage: Qanṣūh al-Ghūrī's* waqf *and his foundations in Cairo*, doctoral dissertation, The Ohio State University, 1993.

192 Revault & Maury & Zakariya, *Palais et maisons du Caire du XIV*[e] *au XVIII*[e] *siècle* (1979? 1984?), p. 42, reprod. in Alhamzeh, *op*. *cit*., pl. 30 on p. 237. (There is some confusion about the source.)

193 For an overview see the article "Waḳf, 1. In Egypt" in *Enc. Islam*, 2nd edn., XI, 63-69, by Doris Behrens-Abouseif.

194 King, "On the role of the muezzin and the *muwaqqit* in medieval Islamic society" (1996), esp. pp. 301-303 / *Synchrony*, V: 623-677, esp. 646-647.

was to be used for the purpose of ميقات, *mīqāt*, which here means regulation of the prayer-times and, perhaps, observation of lunar crescent visibility.[195]

Whilst 50 years ago we had very little idea about the role of the the *muwaqqit*s, we are, thanks to investigations of the treatises they wrote and the instruments they made, and no less, the remarkable variety and sophistication of the tables they compiled, as well as of *waqfiyya*s specifying their numbers and salaries, in a much better position to appreciate the role they played in Cairene society. A useful bibliography is available for any future research.[196]

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195 Witkowski, "Vertical sundial from the Madrasa of Al-Ashraf Inal" (2014), p. 472.

196 Islahi, *Waqf: A bibliography* (2003).

5 — Fatimid and Mamluk poetry on the Cairo wind-catchers

قال المستشرق الايطالي كارلو الفونسو نلينو (١٨٧٢-١٩٣٨):

اللغة العربية تفوق سائر اللغات رونقا وغنى ويعجز اللسان عن وصف محاسنها

> Translation of what the Italian orientalist Carlo Alfonso Nallino (1872-1938) said in Arabic: "The Arabic language surpasses all other languages in beauty and richness; in fact, the tongue is not capable of describing all its merits and excellent qualities."

> "I am a *bādahanj* all filled with emotion, joy, and happiness. High on top of me, the pigeons sing. Inside me, the winds recite love poems." The Egyptian poet Burhān al-Dīn al-Qīrāṭī (*fl*. *ca*. 1350), cited in Rosenthal, "Poetry and architecture" (1977), pp. 13 & 16.

The winds of passion

The reader unfamiliar with Arabic will perhaps be interested to learn that two Arabic words are closely related: هوى, *haw*^{an}, الهوى, *al-hawà*, colloquial *hawà*, meaning "love" and "passion", and هواء, *hawā'*, الهواء, *al-hawā'*, meaning "air" and "wind". This phenomenon was surely partly responsible for the frequent mention of wind and wind-catchers in Egyptian love-poetry.[197] The passion expressed is usually of a homosexual nature;[198] pleasure is also associated with drinking wine.[199]

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197 See already Rosenthal, "Poetry and architecture" (1977), p. 7.

198 On this subject see Sabine Schmidtke, "Homoeroticism and Homosexuality in Islam: A Review Article" (1999): 260-266, a review of two volumes edited by Roscoe & Murray, *Islamic Homosexualities: Culture, History, and Literature* (1997) and by Wright & Rowson, *Homoeroticism in Classical Arabic Literature* (1997).

199 Lewicka, "Alcohol and its consumption in medieval Cairo" (2004), with an extensive bibliography.

The poetry of Ibn Yūnus

The astronomer Ibn Yūnus was renowned as a poet. As luck would have it, some of his verses recorded by his late contemporary, the Fatimid historian al-Musabbiḥī (977-1030), and repeated by the Mamluk biographer Ibn Khallikān (1211-1282), concern the wind.[200] I translate these verses as follows:

> "I charge the wind when it blows, with a message from a yearning lover to his beloved.
>
> By my life, souls are quickened by his being close, and the world is a better place for him and his perfume.
>
> I swear that I left my wine-cup untouched when he left, and for the duration of his absence
>
> His likeness appeared to me in my sleep and has aroused my passion anew, coming to me in the middle of the night, unseen by any chaperone."

The reader unfamiliar with medieval Islamic civilization will observe here an unexpected libertarianism. More of Ibn Yūnus' poetry has survived but most of it has never been studied.[201] A poem by him on the times of prayers is presented in translation in the section on Egyptian astronomical tables in **Ch. 13** below.[202]

(If I may insert a personal note, I will admit that my knowledge of medieval Arabic poetry is very limited. In a course on pre-Islamic Arabic poetry with Prof. Ihsan Abbas at the American University of Beirut in 1970 I found that in many verses I needed to look up every single word but that these words were not all in the available dictionaries and that the

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200 King, *The astronomical works of Ibn Yūnus* (1972), p. 4. See also the articles "al-Musabbiḥī" by Thierry Bianquis and "Ibn Khallikān" by Johannes W. Fück in *Enc. Islam*, 2nd edn.

201 King, *Astronomical works of Ibn Yūnus* (1972), pp. 11 & 18, n. 8.

202 See n. 582.

ensemble of words made no sense to me, not least because they could only be explained in Arabic anyway. It is unfortunately with such limited expertise that I approach the medieval Egyptian poems on the *bādahanj*, which are certainly not for beginners. At least the time I spent scanning Latin poetry at school was not all wasted.)

The *littérateur* al-Ghuzūlī

One of the main sources of the 1977 study by Franz Rosenthal dealing with these poems on the *bādahanj* was a treatise مطالع البدور ومنازل السرور, *Maṭāliʿ al-budūr wa-manāzil al-surūr*, "The risings of the moons and the stages of happiness", by a *littérateur* named علي بن عبد الله الغزولي البهائي, ʿAlī ibn ʿAbdallāh al-Ghuzūlī al-Bahā'ī.[203] This was compiled in Cairo around 1400, and the author died in Damascus in 815 Hijra (= 1412/13), probably in his forties. It was published in an uncritical edition in Cairo in 1882/83. The treatise is arranged in 50 chapters and deals with all manner of conversational topics from gardens to chess to drinking partners to servants to sexual intercourse.

Franz Rosenthal investigated the contents of Chapter 8 which deals with the *bādahanj*. Using the available manuscripts, he showed how these devices achieved a "modest measure of literary celebrity". The entire Arabic text of al-Ghuzūlī's book, albeit unedited, is now available on the internet.[204] One source that was not known to al-Ghuzūlī was the earliest one studied by Rosenthal, namely, Ibn al-Ṭūbī, from the 1st half of the 11th century.[205]

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203 Rosenthal, "Poetry and architecture: The *bādhanj*" (1977).

On al-Ghuzūlī see the more recent article by Michael Cooperson in *Essays in Arabic Literary Biography*, II, pp. 107-118.

204 http://shamela.ws/browse.php/book-5390/page-19.

205 Rosenthal, "Poetry and architecture" (1977), p. 4.

Franz Rosenthal never confided in me why he prepared this article of his. In 1973 I had been happy to present to him a copy of my first serious publication, an article on Ibn Yūnus' corpus of tables for timekeeping, including the first mention of the mysterious table for orienting a wind-catcher, which information he was able to use in his study. In addition to all of his contributions to Islamic history, philosophy, scholarship, and the survival of the Classical heritage in Islamic civilization, Franz Rosenthal had a habit of choosing specific topics in medieval Islamic history and writing definitive studies thereon, such as the concept of freedom, the concept of knowledge, historiography, complaint and hope, humour, gambling, dentistry, child psychology, the handkerchief (*mandīl*), and many other topics. When he published his book *The Herb – Hashish versus medieval Muslim society* (1971) on hashish in medieval Islamic society, we, the three students in his graduate seminar on Islam at Yale University, ventured to ask him whether he had ever tried hashish, to which he answered: "I have also written on suicide in Islam."

The *bādahanj* verses from al-Ghuzūlī's anthology translated by Franz Rosenthal

Note: This section was prepared before I became aware of the new study by Alev Masarwa, which is discussed in the next section.

I now present Franz Rosenthal's translation of the sources, which follows a chronological order. The translation is intended only to give an idea of the kind of material presented by al-Ghuzūlī and its scope. Much of the poetry is obscure. The reader should keep in mind that neither Arabic nor English were Franz Rosenthal's first language. Unless otherwise indicated, al-Ghuzūlī was his only available source. Explanatory footnotes and paraphrases of this difficult text Rosenthal had kept to the absolutely necessary minimum, and they are here omitted altogether. Verses in bold font are discussed further below or have been used to add zest to the images in **Part II**.

Any reader seriously interested in these materials should consult both the Arabic text[206] and Rosenthal's translation, and, no less, his notes. They may well find that text and translation do not always correspond, which is easily explained by the fact that the printed Arabic text is uncritical and the fact that the translation was based on the printed text but with due consideration of variant readings in several manuscripts, all carefully documented by Rosenthal. New critical apparatus has been provided by Alev Masarwa.

I repeat that these translations are those by Franz Rosenthal.

1 **Ibn al-Ṭūbī**

(1st half of the 11th century) – not in al-Ghuzūlī

On a frigid (dull) youth:

> "I came to him on a hot summer day,
> And he gave me a frosty welcome.
> I said: I do not have a *bādahanj* in my house,
> But the face of that fellow is my *bādahanj*."

2 **Abu 'l-Fatḥ Ibn Qādūs**

(d. 1156)

Satirical verses:

> **"You have a *bādahanj* like a sad (mourner) which has**
> **A breath that has become laboured and painfully short.**
> **The zephyr has died in it, and all of us**
> **Cry and mourn for it with tears of sweat."**

3 **al-Qāḍī al-Fāḍil al-Baysānī**

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206 See n. 204 above.

(1135-1200)

Of all known poets, the Qāḍī al-Fāḍil[207] was the one most infatuated with the *bādahanj* (وكان أكثر الناس ولوعا بالبادهنج), for he says:

> "From an epistle to ... dated in (the year) (5)60 (=1164/65) or thereabouts, this being the period from which dates (my) joyful separation from my nest and the high price of my poetry. (By then), I had already composed 50,000 verses, as can be seen by looking them up in their *dīwān*. There are, for instance, **verses approaching 1,000, each piece of which by its inventiveness boggles the mind and by its originality restores (outdoes?) all the beauties of style, on the *bādahanj***, which is extremely hot as if it were breathing like a person with chest pains; or the approximately 1,000 verses on a man with long ears...; or the approximately 10,000 verses on mourning one's native land ... ; or, on specific eulogies and special satirical poems."

4 **Ibn Sanā' al-mulk**

(d. 1211)

> "A *bādahanj* of lofty construction
> But bereft of air (?) –
> May the zephyr's thirst always remain in it,
> As if it were seeking to be cured."

5 **Shihāb al-Dīn al-Sīnakī al-Mālikī**

(d. 1265/66)

> "A *bādahanj* which, when the summer place gets hot,
> Presents the zephyr graciously —
> It listens to the air and, as soon as its breeze whispers to it,
> Denounces it, being its slanderer."

6 **Ibn ʿAbd al-Ẓāhir**

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[207] See n. 452 below.

(1223-1292)

"On a *bādahanj* overlooking the Nile (*al-baḥr*):
I am the joy of those who are glad.
I stimulate the spirit and the blood.
On the Nile's authority, O zephyr, Report freely!"

7 **Abu '1-Ḥasan ʿAbd al-Karīm al-Anṣārī**

(13th-14th century)

"In the comfort of a breeze from a bādahanj that has
Intoxicated us, one finds paradisiacal coolness.
That breeze comes to us from a well-shaped, nice object
Which may be compared to the boon-companion's strainer.
The air has been cleansed, and been flowing in it like pure wine.
Thus, we have named it "strainer of the zephyr"."

8 **Ibn Abī Ḥajala at-Tilimsānī**

(1325-1375)

"A *bādahanj*, may our mansion never be without its pleasant company!,
As if it were an abject lover confronting passion (air).

A *bādahanj* that can be seen in the air
Atop a belvedere, appearing straight ahead (?) —
Behold, my dear beloved, its high rise!
Draw in the wind from it, my confidant (dwelling)!

O *bādahanj*, how much taller you are
Than the willow tree of the tribal pasture!
You have shown excessive foolishness,
Raising your head toward heaven.

A cento:
A house resembling as-Samaw'al's castle has come to brag
About one of its architectural features, saying:
I see my *bādahanj* rise up high in the air,

"Being mightier and taller than those who go after it."

A cento:
O my *bādahanj*, why don't you show pity to one burning
Who bares the flame of violent passion which he had earlier always kept concealed!
You have accustomed us to alms of subtle passion (air).
"Thus bestow upon me a wind coming from you which resembles them (?)!"

A cento:
"O my *bādahanj*, may you never cease being madly inflamed
Like me with love for the habitation (of the beloved)!
My house is always consumed by love for you.
"She (it) was created to have passion for you, just as you were created to have passion for her (it)."
Or more simply:
"Just as I love my beloved and my beloved loves me, I love the cool air of the *bādahanj*, and the *bādahanj* should reciprocate by constantly attracting cool air."

"A *bādahanj* you see like the branch of a willow tree swaying,
Shaking when receiving gifts (of air ?), as if it were a seesaw in motion.

A riddle:
"One with a wing just as Tall as it is wide,
Which, in applying the law of passion (air), has
Never been unjust in the judgment it renders
And which has never flown, although it is
Between heaven and earth.

"A *bādahanj* whose wind
Kindles the fires of violent passion
I have praised, not knowing it,
And my praise went up into the air.

A fine cento:

"In their ignorance, the poets have satirized my *bādahanj*,
Because its zephyr is always sickly.
But when they satirized it, the *bādahanj* said:
"When passion (air) is healthy, let them talk!" "

9 **Burhān al-Dīn al-Qīrāṭī**

(1326-1379)

O pleasant breeze of a *bādahanj* which has constantly
Been giving air and refreshment to our souls,
Fond of attracting the wind from wherever it is,
As if it were a magnet for the wind.

A cento:

"When we came to a certain *bādahanj*, I said, as the thirst
Of its passion (air) cured all (my other) ills:
"My heart has widely dispersed passions.
Since the eye has seen you, my many passions have been brought together." "

"I am a *bādahanj* all filled
With emotion, joy, and happiness.
High on top of me, the pigeons sing.
Inside me, the winds recite love poems."

A cento:
"O *bādahanj*, my passion is 'restricted' to
The flow of the 'extended' passion as I comes to you.
"My passion makes me stop wherever you are. I have
No place after it or before it." "
Or, more simply:
"I wholeheartedly love your abundant flow of air, and my desire for the refreshing air makes me stick close to you. There is nothing and nobody that could make me budge from your place."

"O *bādahanj*, for which we (*i.e.*, I) have a sound passion!

No words are able to do justice to your qualities.
“The only thing I want is to direct my critics to the fact
That my view with regard to my passion for you is the right one.”

A cento:
“A *bādahanj* in which the air of east and west
Flows according to the best manner and method –
“When the winds of the atmosphere come to it in disarray,
They blow in it in no other way but an orderly one.”

A *bādahanj* speaking: My excellence
Not concealed or hidden from you (is this):
The breeze of the zephyr (*ṣabā*) longs (*taṣbū*) for my breathing (*li-anfāsī*),
And the kisser of mine kisses the ground.

“Our *bādahanj* is similar in shape to a wine strainer.
Thus, the air is purified and strained through it.
A good breeze emerges from it, bringing about drowsiness,
But were a drunk man to sleep in it, he would wake up.”

I give my life for a *bādahanj* charged
With extinguishing the fires of violent passion.
When praised for its qualities, it recites: (I deserve praise,)
“Because I am satisfied with bearing passion (carrying air).”

“A mansion where our *bādahanj* stretches up high,
Love-sick, curing the thirst of violent passion —
If, when it is hot, a grating there is opened,
“Love for her came to me, before I knew what love was.” ”

A riddle:
(1) “Our divergent passions have become unified
(2) In one loftily looking down its nose upon high places, disdainfully,
(3) Having a wing, yet never having flown, though all the birds are familiar with it.
(4) Its wing shows its opening high over us all the time.

(5) How much have (men) in exalted positions longed for its air (passionately for it)!
(6) To how many a sad lover has it offered its ennobling (position),
(7) While always sending its soothing (air) in his direction!
(8) The wind obliterates the words of him who blames him (it) for his (its) passion.
(9) How many gravely ill hearts have been cured by its healthy thirst!
(10) Its spirit is subtle, and its essence slanted.
(11) **I see that the love of passion (air) has turned it away from the *qibla* of Islam.**
(12) In spite of its passion (air), its sides have never been inclined.
(13) It controls its passion (air), managing it however it wishes.
(14) How often has a cloud turbaned its bare head!
15) Its (quiet) dweller has never ceased being in commotion since becoming used to it.
(16) Whatever air appears to it, it grabs.
(17) The essence of the young man of al-Walīd harmonizes with its essence.
(18) The namesake of its dwellers shows his injustice in the West.
(19) (He/it is) the wealthiest (?) of those whose judgments are fair among human beings
(20) How many relationships has it established between dwellers and dwellers (?)!
(21) Young men took up winter quarters in it, just after summer had begun for them.
(22) Generosity has come fairly from it to people of quality (?).
(23) A spendthrift no right-thinking person would call stupid —
(24) I praise its activity, in spite of its spendthrift and wasteful habits.
(25) Whatever it squanders wastefully, we are grateful for the squandering it does.
(26) **Half of it together with *j-b-1* (?) is a king (*malik*^{un}) whose assaults are destructive.**
(27) **Two-thirds of it misspelt – the lip has revealed the essential meaning (*fiṣṣ*) of what it says.**
(28) **And one-third of it is two letters, rather one letter. Leave alone**

anyone who tampers with it!
(29) How many pleasant good things have been entrusted to its breaths!
(30) How do they (the breaths) sway, coming from a branch (*ghuṣn*) with a slender figure!
(31) **Its weak (part) is the sound one, in the view of those who know it.**
(32) **Its smell is known as sweet by a friend (*khill*) who perceives it.**
(33) **Its white garment always shows its great elegance.**
(34) **Its last part is a work having been composed by a scholar,**
(35) **And a sultan's house, in which he has come to guard his treasures.**
(36) **Two-sixths of the word are the *kunya* of a proud group,**
(37) **And for one-sixth of it, I see, heaven, earth, and water are the familiar habitat.**
(38) **Reveal an enigma I have posed (*qultuhu*)! The likes of you can do it.**

(39) The daylight of your intelligence wipes out the obscurity of the dark.
[Verses 40-48 have nothing to do with the *bādahanj*.]

10 **Ṣadr al-Dīn Ibn ʿAbd-al-Ḥaqq**

(d. *ca*. 1378/79)

"Don't sleep in the *bādhanj*
For there is no medicine for those made sick by it.
The individual that steals passion (air)
At night is not safe."

I repeat that other relevant poems have been published by Alev Masrwa.

A few comments are perhaps in order.

Rosenthal's explanation of this important verse

عن قبلة الدين ارى ... حب الهوى قد صرفه

I see that the love of passion (air) has turned it away

from the *qibla* of Islam –

was unfortunate[208] but the verse is incomprehensible without an understanding of the orientation of the *bādahanj*. In fact, the verse means nothing more than that the *bādahanj*, which faces roughly north-north-east, is perpendicular to the *qibla* of the *ṣahāba* in Cairo, which was east-south-east.

A riddle involving the word *bādahanj*

More down-to-earth is the riddle about the letters of the name *b-ʾ-d-h-n-j*, which extends over several verses: 26-28 & 31-37. Franz Rosenthal attempted to decipher some of these clues, but most remain obscure.

We have already mentioned that in one manuscript of al-Ghuzūlī's book it is noted that these letters correspond in the standard medieval Arabic alphanumerical (*abjad*) notation to the numbers 2-1-4-5-50-3. However, this does not seem relevant to a solution of the riddle.

I have been able to add only a couple of solutions. The question-marks below relate to the problems of the solution to the riddle, not only to the meaning of the verse.

(26) ونصفه مع جبل ... ملك سطاه متلفه

Half of it together with *j-b-l* (?) is a king (*malik*^{un}) whose assaults are destructive. ??

(27) تصحيف ثلثيه جلت ... فص حديثه الشفة

Two-thirds of it misspelt – the lip has revealed the essential meaning (*fiṣṣ*) of what it says. ??

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[208] Rosenthal, "Poetry and architecture", p. 16, n. 75: "The passion of a Muslim lover, *e.g.*, for a Christian, may turn him away from Islam. Correspondingly, the desire of the *bādhanj* for air requires it to face north(west), instead of south(east) toward Mecca."

(28) وثلثه حرفان بلل ... حرف فدع من حرفه

And one-third of it is two letters, rather than one letter (?). Leave alone anyone who tampers with it! ??

(29) انفاسه كم اودعت ... محاسنا مستلطفة

How many pleasant good things have been entrusted to its breaths! ??

(30) كم رنحت من غصن ... ذي قامة مهفهفة

How do they (the breaths) sway, coming from a branch (*ghuṣn*) with a slender figure! ??

(31) معلته وهو الصح ... يح عند من قد عرفه

Its weak (part) is the sound one, in the view of those who know it. Rosenthal suggested this might refer to Persian *bād*, meaning "wind". The word has the form of an Arabic weak (-medial-vowel) verb, although it has no meaning in Arabic.

(32) يجري لحل المشكلا ... ت لم يخف توقفه

Its smell is known as sweet by a friend (*khill*) who perceives it. ??

(33) وثوبه البيض لا ... يزال يبدي صلفه

Its white garment always shows its great elegance. It seems probable to this writer that this refers to the expansive garment known as the *bādahanj* and mentioned by the 15th-century Egyptian historian Ibn Taghrībirdī.[209] See also below "What's in a name?" in **Ch. 11**.

(34) اخره مصنف ... لعالم قد صنفه

Its last part is a work having been composed by a scholar. This appears to this writer to refer to the word نهج, *nahj*, meaning "open way, method", sometimes used as the beginning of a title of scholarly books.

(35) وبيت سلطان غدا ... يصون فيه تحفة

209 Ibn Taghrībirdī, *al-Nujūm al-ẓāhira*, IV, p. 43. See n. 442 below.

And a sultan's house, in which he has come to guard his treasures. ??

(36) يكني بسدسي لفظه ... عصابة مستنكفة

Two-sixths of the word are the *kunya* of a proud group. Rosenthal suggested the supra-natural جن *jinn*.

(37) وسدسه أرى السماء ... والأرض والماء يألفه

And for one-sixth of it, I see, heaven, earth, and water are the familiar habitat. This, as Rosenthal suggested hesitatingly, surely refers to the *alif* and *hamza* (minor glottal stop) occurring in the words سماء, *samā'*, for 'sky or heaven', with a *hamza* after the *alif*; أرض, *'arḍ*, for 'earth', with a *hamza* over the initial *alif*; and ماء, *mā'*, for 'water', with a *hamza* after the *alif*.

Perhaps some reader can complete the solution of the riddle. al-Qīrāṭī (line 38) encourages us enthusiastically:

فاكشف معمى [قلته] ... فمثلكم من كشفه

"So (go ahead and) solve the riddle I have posed;
the likes of you can do it."

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The association of the *bādahanj* with the astronomer Ibn Yūnus and his period – *ca*. 1000 – is strengthened by the fact that the earliest reference to the *bādahanj* in Cairene poetry is in the writings of Ibn al-Ṭūbī, who flourished in the early 11th century. The poet – see above – wrote about a dull youth: "the face of that fellow is my *bādahanj*." Ibn Yūnus would have appreciated this. He himself had a son who was so dim-witted that when his father died, the son washed the ink off his father's papers and sold them by weight in the soap-market.[210]

Alev Masarwa and the poetry on the *bādahanj* in the anthology of Ibn Abī Ḥajala

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210 King, *Astronomical works of Ibn Yūnus*, p. 3.

In August 2019, when I thought that this study was virtually completed and ready for editorial revision, I became aware of the 2017 study of the *bādahanj* in medieval Egyptian poetry by Alev Masarwa. Her study is entitled “Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space”,[211] and it deals with the anthologies of the 14th-century scholars al-Ghuzūlī and Ibn Abī Ḥajala.[212]

Masarwa’s study is very much that of an Arabist / orientalist who is well able to master the intricacies of medieval Arabic poetry. Whilst her study started as a paper given at an Urban Studies conference, her publication is in a collection of essays on the singularly important medieval scholar Ibn Abī Ḥajala from Tlemcen, who became head of a *khānqāh* or Ṣūfi convent outside Cairo. Essentially her meticulous study supplements Rosenthal’s 1977 study with poems on the *bādahanj* from a second anthology by Ibn Abī Ḥajala, of which Masarwa worked on the unique copy in Istanbul University Library. In addition, she had edited the text of al-Ghuzūlī in so far as she presents critical apparatus based on the available manuscripts.

It is beyond the scope of the present undertaking to comment on the poems that Masarwa has so meticulously documented. She gives the impression that *bādahanj*es were found in Syria as well as in Egypt, but there is apparently little known architectural evidence for this. Nor did Rosenthal claim any presence in Syria. It is simply that both al-Ghuzūlī and Ibn Abī Ḥajala came to Cairo from Damascus. Note, however, that the early report

[211] Masarwa, “Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space” (2017). The Syrian connection is discussed on p. 115.

[212] See the article “Ibn Abī Ḥadjala” by J. Robson & U. Rizzitano in *Enc. Islam*, 2nd edn., and the article “Ibn Abī Ḥajala” by Beatrice Gründler in *Essays in Arabic Literary Biography*, II, pp. 118-126, and especially the volume of studies devoted to Ibn Abī Ḥajala and edited by Nefeli Papoutsakis & Syrinx von Hees, in which Masarwa published her article.

of al-Muqaddisī – see **Ch. 4** – also mentions *bādahanj*es in Syria, and in abundance.

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We now turn to illustrations of the Cairo wind-catchers. These all post-date the period when the wind-catchers were legion, namely, from the 10th to the 17th century. Therefore, we shall often find solitary wind-catchers, sometimes in a state of disrepair, and occasionally groups of these devices in particular regions of the city. As usual it is the exceptions to such rules which are of particular interest.

6 — The wind-catchers in early European prints and paintings

"There is a fortune to be made for painters in Cairo, and materials for a whole Academy of them. I never saw such a variety of architecture, of life, of picturesqueness, of brilliant colour, and light and shade. There is a picture in every street, and at every bazaar stall." The British writer William Makepeace Thackeray (1811-1863) in his *Notes of a journey from Cornhill to Cairo* (1846), pp. 278-279.

"Le principal élément de reconnaissance des capteurs de vents est l'auvent surplombant les toitures, les façades et les rues. **Aucune description de la ville ne fait référence à l'ambiance fantastique que devait dégager, autrefois, leurs silhouettes.** Seul les vues perspectives des bâtiments entourant l'Azbakiyya et de Bulaq, dressées par les savants de l'Expédition d'Égypte, à la fin du XVIIIe siècle, en donnent une idée." / "The main element for recognizing the wind-catchers is the top part where the wind enters, overhanging the roofs and façades of the buildings and the streets. **No historical description of the city so much as mentions the fantastic ambience which their silhouettes must have provided in their day.** Only the perspective views of the buildings surrounding the (lake of) al-Azbakiyya and (along the Nile at) Bulaq, drawn up by the scholars associated with the Egypt Expedition at the end of the 18th century, give some idea of this ambience." Olivier Jaubert, "Capteurs de vents" (1995), p. 174 (my emphasis).

"An important function of Orientalist painting was to create a visual record of places of interest. Such images were aimed at a growing market of Europeans and North Americans who either visited the Middle East and North Africa or were interested in the regions from afar." Julia Tugwell, Curator, British Museum, in "An introduction to Orientalist painting", British Museum blog, 2019. (These days we seldom read how it actually was. This is a pleasing exception.)

> “Examples of early Orientalism can be seen in European paintings and photographs and also in images from the World’s Fair in the U.S. in the 19th and early 20th centuries. The paintings, created by European artists of the 19th and early 20th centuries, depict the Arab World as an exotic and mysterious place of sand, harems and belly dancers, reflecting a long history of Orientalist fantasies which have continued to permeate our contemporary popular culture.” Evelyn Alsultany, “What is orientalism?” (n.d.).

Alas, the Cairene wind-catchers are not known to be featured in medieval Egyptian manuscript paintings (formerly called miniatures).[213] So it is to the European painters who were captivated by the Egyptian world to whom we must turn to see what they looked like. **The reader should keep in mind that by the early 19th century most of the Cairo wind-catchers had disappeared, so that images from the early 19th century onward are not a particularly reliable source for recreating the medieval scene.** In addition, around 1800 the major monuments in Cairo, such as the Mosque of ʿAmr, the Mosque of Ibn Ṭūlūn, the Mosque of al-Ḥākim, let alone the Tombs of the Caliphs, were in a fairly ruinous state. The woodcuts and paintings we present tend to focus on buildings and areas of the city that were more vibrant and more picturesque.

The painters of these images are traditionally labelled “orientalist”, a term adapted from the French, but more appropriately they were men who loved or were fascinated by that world and who used their talents to document some of its most remarkable aspects. Most of them were not exclusively involved in painting Near Eastern scenes, and in judging them and their “orientalism” it would be a mistake to take one of their supposedly offensive paintings (as some have done on the covers of their books) and

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[213] The reader may appreciate my surprise in finding a plethora of ‘miniatures’ in a manuscript of a 16th-century Egyptian astrological treatise preserved in the Topkapı Library, one of which represented Ibn Yūnus presenting his *magnum opus* to the Fatimid Caliph al-Ḥākim – see **Pl. S1**.

ignore all their other productions. The importance of these painters and their productions is the greater because many of the edifices they featured in their work have vanished, and many of the scenes they captured are now unrecognizable. Would that there existed an overview of the available materials such as Paul Chevedden prepared for the photographic resources – see **Ch. 7** below. I cannot claim to have exhausted the scene. In 2019 Sotheby's of London auctioned some 78 orientalist paintings in its "Oriental Sale", including a previously-undocumented original copy of Gérôme's "Prayer on the rooftops".[214] In the same year, an auction-house in France announced some 50 "orientalist"-type paintings by artists whose names were new to me, but fortunately their paintings did not feature any Cairene wind-catchers.[215] There is a list of names of hundreds of orientalist painters on Wikipedia – I fortunately found it after I had finished the research for this section of my study.[216]

The images presented in **Part II** demonstrate that wind-catchers were still a common feature of Cairene architecture throughout the 19th and into the early 20th century. There are, of course, many images of Cairo available which show no wind-catchers at all. We can attribute this primarily to the fact that most available images do not show roofs of buildings. None of our images show stair-cases or toilets; this does not mean that the buildings depicted did not have stair-cases or toilets.

My purpose here is simply to document the sub-group of artists whose work shows some of the few remaining wind-catchers of historical Cairo. We are not primarily concerned with artistic merit, but rather with what we can learn from these images about the subject of our enquiry. We are also not concerned with national(istic) achievements, so the following

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214 www.sothebys.com/en/auctions/2019/the-orientalist-sale-l19100.html.

215 www.gros-delettrez.com/catalogue/100241.

216 https://en.wikipedia.org/wiki/List_of_Orientalist_artists.

artists are not grouped together according to national origins (as they are, simply for convenience, in **Part II**).

European travellers and cartographers in the 15th-18th centuries

What is supposedly the first representation of Cairo by a European traveller from *ca*. 1480 does not serve our purpose – **Pl. B1**. The roofs are all /\-shaped, as one might expect in a European city, and occasional towers do not represent wind-catchers.[217] The image of the Nile Valley by the German canon Bernhard von Breydenbach is a small part of a long wood-block printed panorama of the Near East focussing on Jerusalem published in 1486 and widely circulated in Europe. The image of Cairo features several Christian pilgrimage sites, and also the Citadel, Babylon and “Chayru”.[218]

Some German travellers to Cairo in the 16th century are a major disappointment for the present study because whilst their panoramas of the city show hundreds of houses with flat roofs, they show not a single wind-catcher – **Pl. B2**.[219] This deficit results from the fact that the artists were not actually depicting Egyptian houses, but, rather, European ones, with flat roofs.

The great city atlas (*Civitates orbis terrarum*), published in Cologne in 1572 and prepared by Georg Braun and illustrated by Franz Hogenberg, contains views of 546 cities around the world. In the image of Cairo – **Pl. B3** – there are plenty of fake pyramids shown, but again no particularly Islamic features.

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[217] Source unknown. (I have forgotten where I found this.)

[218] Warner, *Monuments of historic Cairo* (2005), pp. 2-3.

[219] See the various illustrations in Meinecke-Berg, “Eine Stadtansicht des mamlukischen Kairo aus dem 16. Jahrhundert”.

The 1513 nautical atlas of the celebrated Turkish scholar and navigator Pīrī Re'īs (*ca*. 1480-1553)[220] serves us no better in this regard; the illustrations of Cairene houses follow the European models, with a few mosques added for good measure – **Pl. B4**.[221] An illustration of a Cairo wind-catcher by Prosper Alpin *ca*. 1600 is quite a surprise when one sees it for the first time – see below.[222]

Matteo Pagano

The Venetian cartographer and printmaker Matteo Pagano (*fl*. 1538-1562) published the bird's eye view of Cairo shown in **Pl. B5**. Here we find both domes and minarets.[223] This was to remain the standard Western representation of Cairo for two centuries. Pagano's 21-section view of the city has been studied in depth and in minute detail by the American architect and architecture historian Nicholas Warner.[224] I have not seen the sumptuous volumes of his publication destined for scholar princes. However, at first sight it seems clear that Pagano does not illustrate ANY wind-catchers on the flat roofs of the houses of Cairo, and I could not determine whether Nicholas realized that they were missing. However, in October, 2019, he assured me (in an email from Sohag) that they are indeed occasionally shown on some rooftops, and, yes, they are there – **Pl. B6**. They are standing vertically like double-panel room-dividers, with the panels partially open to achieve stability. They are inevitably open toward three different directions.

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220 See the articles in *DSB* and *Enc. Islam*, 2nd edn.

221 Moench, "Built form during the Mamluk Sultanate" (2015), p. 59.

222 Mentioned in King, "Architecture and astronomy" (1984), p. 97, n. 4 / *Synchrony*, VII: 781-782.

223 Moench, "Built form during the Mamluk period" (2015), p. 45.

224 Warner, *The True Description of Cairo – A sixteenth-century Venetian view* (2006). A summary is in www.arcadian-library.com/study-series-no-2.php.

Thus Pagano provides us with the first images of the Cairo wind-catchers, if only for eyes that can see. Also one has to know what they looked like in order to recognize how he represented them.

Prospero Alpino

The physician and botanist Prospero Alpino (1553-1617) from the Republic of Venice spent three years in Cairo in the 1580s. He mentioned the wind-catchers, stating that the Cairenes used "vast ducts, similar to large trunks situated in the interiors of all the houses to receive the cold air." Sometimes these were made of wood, he says. His splendid illustration of such a duct, mingled with some Ancient Egyptian statues, is fairly explicit – **Pl. B7**. We have already noted his description of such devices in **Ch. 4**.

Antonius Gonzales

The Spanish priest Antonius Gonzales (1604-1683) visited Egypt in 1665-66 and wrote a book about his experiences.[225] He has left us an engraving of an Egyptian house, which includes a "cabane pour capter le vent" / "a hut or cabin for capturing the wind" – **Pl. B8**. **This is the first known deliberate representation of the upper part of a Cairo *bādahanj*.** The wind-scoop shown has a flat roof, and brings to mind the *bādahanj* on the complex of Muḥibb al-Dīn al-Muwaqqiʿ (Jaubert #27), dating from 1350 – **Pls. Q1-3**. Gonzales described the device as follows:

> "Au-dessus de la grande salle de ces maisons (des princes) existe une ouverture ovale ou carrée couverte d'une espèce de cabane par laquelle le vent du nord entre dans le salon et le rafraîchit." / "Above the large room of these houses (of princes) is an opening, either oval or square, covered by a hut or cabin by which the north wind enters into the room and cools

225 Gonzales, *Voyage en Égypte*, 1977 edn., following p. 170 (ex 84), with the text on pp. 108-109 (ex 49-50).

it."

These remarks occur in a section on princely houses, but it should not be assumed that the wind-catchers were found only on these.

The transition from simple medieval-type sketches of houses in city-scapes to almost modern-looking engravings of details of Cairo scenes is impressive indeed to a novice like the author. Some of the first visitors to Egypt in the 18th and early-19th centuries have left us precious images of Cairo.

Frederic Louis Norden

Particularly imposing are the engravings the Danish naval captain and explorer Frederic Louis Norden (1708-1742). Upon the request of King Christian VI of Denmark, Norden made a voyage up the Nile as far as the Sudan in 1737-1738. He made abundant notes, observations and drawings of everything around him, including people, pharaonic monuments, architecture, installations, maps, etc., all of which was published in the posthumous *Voyage d'Égypte et de Nubie* (Copenhagen, 1755, & Paris, 1795).[226]

The view of the region of Dayr al-Tīn near Old Cairo is a rather modest image that Norden has captured brilliantly – **Pl. E1**. There are two rather large wind-catchers on neighbouring two-storey houses, one fairly intact and the other on its way to becoming rickety. Norden's "Perspective du Vieux Caire" shows a three-storey house with a wind-catcher on the roof – **Pl. E2**. His view of the coast-line at Alexandria is deceptive insofar as the numerous contraptions looking like *bādahanj*es on the buildings along the coast are simply letters of the alphabet, keys to the function of the buildings – see **Pls. E2-E3**.

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226 Norden, *Voyage d'Égypte et de Nubie* (1755/1795), available on the internet. For the context see Buhl, "Norden and his Danish predecessors as travellers in Egypt" (1986).

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(If I may insert a personal note here, I can very much relate to Norden's adventure. In the summer of 1963 I visited Egypt for the first time, starting at Alexandria, thence to Cairo, and thereafter slowly up the Nile to Wadi Halfa. Always 4th-class on the trains, the best way to travel. What I saw in that Sudanese border town and beyond blew my mind: Africa and the Near East in one; the Nile in all its glory; men, women and children in all shades from black to white; Arabic the *lingua franca*; pyramids older than those in Giza; ... . So it was in Wadi Halfa in 1963, which in 1964 disappeared from the face of the earth because of flooding caused by the new Lake Nasser, that I resolved to return to the Sudan for a more serious venture. Just a year later, I arrived in Khartoum in the service of the Sudan Government Ministry of Education, and I worked for two years in Atbara on the Nile and one year in El-Fasher in Darfur. If I had not travelled to the Sudan in 1963 and returned there in 1964, I would not be writing this now.)

The *Description de l'Égypte*

> "(*La Description de l'Égypte*) est un œuvre qui constitue un champ fécond pour l'investigation. Enfoui dans les rayons des grandes bibliothèques comme ouvrage 'rare' ou 'réservé', ce livre attend que les chercheurs conjuguent leurs efforts pour l'étudier dans une optique pluridisciplinaire." / "The *Description de l'Égypte* is a work that constitutes a fertile field of investigation. Hidden away in the stacks of the great libraries as a work that is 'rare' or 'on reserve', this (enormous set of volumes) is waiting for researchers to join forces in order to study it with multidisciplinary vision." Boussif Ouasti, "*La Description de l'Égypte*" (1990), pp. 81-82.
>
> "Les livres et les conversations des voyageurs anglais ne citent jamais (*La Description de l'Égypte*)." / "The books and conversations of English travellers never mention or quote (*La Description de l'Égypte*)." The French orientalist Eusèbe de Salle, *Pérégrination en Orient*, Paris, 1840, II, p. 1, cited in Ouasti, "*La Description de l'Égypte*" (1990), p. 81.

> “France perfected the art of the *dessinateur* in the early 19th century, relating it to the newer crafts of lithography, colored printing from metal or stone plates, and eventually photography. This art can be relished in the thousands of drawings assembled in the *Description d’Egypte,* Napoleon’s eternal gift to the civilization of the Nile Valley.” George Scanlon, introduction to *Islamic art in Cairo – E. Prisse d’Avennes* (1999), p. vii.
>
> “The *Description de l’Égypte* ... that great collective appropriation of one culture by another.” Edward Said.

It is rare that the commander of an invading army sends an additional battalion of scholars to document the territory currently being invaded. But Napoleon did just that in Egypt at the end of the 18th century. Aside from all the military personnel, some 167 scholars participated, including 21 mathematicians, 3 astronomers, 17 civil engineers, 13 natural scientists and mining engineers, 4 architects, 8 drawing specialists, 10 literary specialists, and 22 printers equipped with Latin, Greek and Arabic letters.

The result was the monumental series of 23 volumes of text and illustrations comprising the *Description de l’Égypte*, dealing with every aspect of life in Egypt, as well as its antiquities. In these volumes there are innumerable illustrations of wind-catchers, never previously exploited pictorially for an overview of this architectural feature – see **Pls. C1-17** for the images relevant to the present study.[227] Some of the relevant images

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[227] Listed in the bibliography as *Description de l’Égypte*. References given here are to the appropriate volume of the two volumes of the *État moderne* and number of the plate (in the 10-volume edition), and after a slash (/) a page number in the 1994 German paper-back edition (also French edition). The provision of this Taschen edition enabled every interested person to own a copy at least of the illustrations (thankyou, Taschen-Verlag!).

The entire work – illustrations and text – is available at http://descegy.bib—*—alex.org/index1.html, and for this we must also be very grateful, although the image-control is primitive by modern standards and nobody thought to insert a table of contents, or a ‘fast-forward’ function, or a ‘search’ function. One must therefore

with wind-catchers are discussed but not illustrated by Olivier Jaubert, who probably assumed that his readers had access to the *Description*, but, alas, his study of the Cairo wind-catchers had very few readers anyway. (I am aware of only two authors – namely, Nicholas Warner & Lamees al-Dasouqi – who besides myself have profited from his work.)

Now amongst the numerous professions illustrated, that of the constructor of wooden frames is not featured, not even for *mashrabiyya*s. Also all of the numerous wind-catchers appearing in these volumes are there by chance rather than by design. We can be grateful for the extravagant sumptuosity which inspired the French scholars to do things properly so that we can now profit from their labours.

The various essays collected in the text volumes under the rubric *État moderne* are not directly related to the images. Rather they address different topics such as the astronomical observations made by the French to derive the longitudes and latitudes of localities in Egypt; the city of Alexandria; the Nilometer (a first-rate description of all the inscriptions

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move laboriously forward page by page through hundreds of pages in each of the text volumes in order to find, if one is lucky, an index at the end which one may no longer need.

For recent studies of the work, its milieu and its influence, mainly by French and Egyptian scholars, see Humbert *et al*., *Boneparte et l'Égypte – feu et lumière* (2008). An interesting overview is in Ouasti, "*La Description de l'Égypte*" (1990).

(The 1987 Princeton production *Monuments of Egypt: The Napoleonic Edition: the Complete Archaeological Plates from la Description de l'Egypte*, edited by Charles Gillespie and Michael Dewachter, contains useful introductory chapters by the editors. However, "archaeological" here means "only Ancient Egyptian", and all "modern Egyptian" plates, as well as those dealing with "natural history", have been dropped. If anybody had ever bothered to survey the materials on Islamic Egypt, one of the things they would have found would have been the wind-catchers.)

Olivier Jaubert, "Capteurs de vents" (1995), appropriately mentions and documents some of the individual wind-catchers featured in the *Description*, but alas gives no illustrations.

by the engineer, orientalist and printer Jean-Joseph Marcel (1776-1854)); and the habits and customs of the Egyptians. One searches in vain for even a comment on the wind-catchers that feature in so many of the plates, or on the craftsmen who made them.

The images captured by the French artists which are relevant to our study are the following:

C2 A view of the square of Ezbekiyya, at the time when the annual floods turned it into a lake, seen from the east side, and showing over a dozen wind-catchers including some very large ones. (I, pl. 41 / 608-609.)

C3 A detail of the previous image. (I, pl. 41 / 609.)

C4 Another view across the lake which shows several wind-catchers on the left but none on the buildings to the right. (I, pl. 43 / 612-613.)

C5 Another detail of a view from the southern side of the lake. (I, pl. 43 / 612.)

Jaubert (p. 205 *ad* #62), suggests that the wind-catchers shown in pls. 41-43

> "sont parfois des dimensions très importantes sans doute exagérés par l'artiste" / "are sometimes of very considerable dimensions and have doubtless been exaggerated by the artist".

I wonder!

C6 This view of the splendid facade of the Sultan Ḥasan Mosque shows a large house near the main portal with two substantial wind-catchers on its roof. (I, pl. 38 / 605.)

C7 A view of the port and main mosque of the port of Būlāq shows four wind-catchers on distant houses. They are open to the left-hand side in a direction roughly parallel to the Nile. (I, pl. 25 / p. 590.) (Būlāq replaced al-Maqs as the port of Cairo when the Nile changed it course to the west.)

C8 The large exterior courtyard of the house of ʿUthmān Bey is dominated by a splendid and very large wind-catcher with fine decorative screening. (I, pl. 50 / 620.)

C9 The garden of the Palace of Alfī Bey, whose owner fled to Upper Egypt when the French invaded and whose virtually new Palace was commandeered by their army as their headquarters and charmingly called "l'Institut". Behind is the Palace, and **an enormous wind-catcher, perhaps three to four times as wide as the one on the Musāfirkhāne**. To the right, part of another such enormous wind-catcher is visible. Let no reader think that these were devices introduced by the Ottomans or by the French; they are the culmination of a purely Egyptian phenomenon. Or maybe they are not the culmination: such enormous wind-catchers were to be found in Cairo already in Fatimid times. In 1841 this Palace suffered the further indignity of being converted into the first Shepheard's Hotel. (I, pl. 52:2 / 622.)

C10 Another view of the same enormous wind-catcher from a different angle. (I, pl. 40 / 607.)

C10aA view, perhaps from the Nile, of "Old Cairo" with a small mosque in the foreground and three substantial wind-catchers on houses in the distance. (I, pl. 18 / 583.)

C11 The architects' plans of the house, or rather, Palace, of Ḥasan Kāshif, which were to show the side view of a wind-catcher with a roof sloping at about 30° and the frontal views of two very large wind-catchers with highly decorated grids. (I, pl. 54 / 624.)

C12 A view from within the courtyard of the same Palace shows a double wind-catcher roof with each side at about 70° to the horizontal, thus: /\ . The wind would enter through the triangular aperture facing north and, finding the southern side blocked, would be forced into the house below. This appears to be a unique example of a special kind of *bādahanj* called *mujannaḥ*, "winged", as mentioned in the astronomical sources. (I, pl. 56 / 626.)

C13 Three views of Cairo house-types show one with a wind-catcher, another with two, and a third with something weird which may also be a wind-catcher. (II, pl. 102:14-16 / 681.)

C14 A view over an extensive garden plot outside the City shows two wind-catchers on houses in the distance, the one on the right being a tower rather simply a scoop. (II, pl. xxix / 714.)

C15 Two views of the small town of Minya with the Nile in the distance and from the other side of the river show three wind-catchers on a largish building next to the river. (I, pl. 4 / 565 & pl. 5 / 566.)

More could be said about the wind-catchers in each of these scenes from the *Description*, and I hope someone qualified will do that. Note that in none of the numerous prints mentioned above is there any sign of a wind-catcher in a state of disrepair or imminent collapse. This is not the case with the paintings of the following century.

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Another extraordinary, monumental and extravagant work which is less well known than the *Description* is the 16-volume *Monumenta cartographica Africae et Aegypti* by Prince Youssouf Kamal, published in Cairo between 1926 and 1952. This contain maps and copies of maps and historico-geographical texts on Africa and Egypt from Antiquity to modern times.

Remarks on the French and the English

> "Le Pacha d'Égypte a adressé récemment un défi des plus singuliers aux enfants de la perfide Albion, par l'entremise du consul général anglais, actuellement au Caire. Le Pacha d'Égypte se fait fort de battre les membres du *Jockey-Club* anglais sur le terrain du *turf* ; en d'autres termes, il parit pour ses chevaux arabes contre les chevaux de race anglaise. On conçoit combien une pareille prétention pique l'honneur si chatouilleux sur ce point de tous les sportsmen de la Grande-Bretagne." / "The Khedive of Egypt has recently addressed a challenge of a most remarkable kind to the sons of the "Perfidious Albion", through the intermediary of the English Consulate General, currently in Cairo. The Khedive of Egypt will be going all out to beat the members of the English *Jockey Club* on the race-field; in other words, he is betting on his Arab horses against the horses of English stock. One can conceive

how much such a pretension would prick the honour, so sensitive on this point, of all the sportsmen of Great Britain." The editors of *Journal des haras, chasses et des courses de chevaux* (*Journal of stud-farms, hunting and horse-racing*) 4 (Paris, 1849), p. 324.

"I think I shall like the Egyptians, they are a fine, good-tempered, rather noble-looking lot, they appear to belong to a vastly higher type of humanity than the French for instance." The first impressions of Joseph McPherson, a Scotsman who arrived in Egypt in 1901 and stayed until 1945. See Carman & McPherson, eds., *Bimbashi McPherson – A life in Egypt* (1983), p. 27.

"Il est bon d'avertir que tout Européen passe ici (à Alexandrie) sous le nom de Franc. Ceux qui y demeurent sont les François et les Anglois. Les premiers se flattent de se faire mieux respecter ; mais les derniers font peut-être un meilleur commerce." // "It is appropriate to point out that here every European is called a 'Franc'. Those who live here are the French and the English. The former flatter themselves at being more respected, but the latter perhaps do better business." The Danish traveller Frederic Louis Norden, *Voyage d'Égypte et de Nubie*, Copenhagen, 1755, I, p. 46.

"We left Egypt alone after (the disastrous Seventh Crusade in 1249-50), but by the late eighteenth century we were back. To be fair, it was Napoleon who started it. ... ." Stuart Laycock, *All the countries we've ever invaded ...* (2012), pp. 73-74.

"It is estimated that about 350,000 French people live in the UK, with approximately 400,000 Britons living in France." Anonymous, "France – United Kingdom relations" (n.d.), https://en.wikipedia.org/wiki/France–United_Kingdom_relations#20th_century.

The rivalry between the French and British governments and peoples around the end of the 18th century extended to scholars and their publications. The *Description de l'Égypte* was seen as a challenge by some British. Their own achievements were thought by them to be better, but not by the French. One British orientalist, Edward Lane, even produced his own *Description of Egypt*, intended to rival its French predecessor. In

the early 20th century this rivalry would continue, now between the leading (and virtually only) British historian of Islamic architecture and his French contemporaries. Hautecœur & Wiet published on the mosques of Cairo. Creswell published the definitive work on the religious architecture of Cairo. The French scholars published the definitive work on the historical palaces and houses of Cairo. As a British-born orientalist writing these lines in France, I can at least try to do some justice to both traditions. But this is a very amateur account of the history of the history of Cairene architecture.

Of some interest in this regard is Creswell's review of Hautecœur & Wiet's book on the Cairo mosques. He had little time for Hautecœur, since the latter was primarily a historian of European art and not a specialist in Islamic architecture. Alas it was Hautecœur who responded to Creswell's review in the strongest terms, suggesting *inter alia* that Creswell did not understand French. Then came Wiet's review of Creswell's book on the mosques of Cairo, on a very high scholarly level, laudatory and appreciative in the extreme, with useful additional information.[228] Criticism of Creswell went on for decades even after the French Gaston Wiet had reviewed his work so nicely. Even the *Grove Encyclopaedia of Islamic Art* remarks:[229]

> "An extraordinary personality, Creswell was opinionated and prejudiced and his patriotism childishly chauvinistic, yet his passion for Islamic architecture, the monuments of Cairo and almost all other aspects of Islamic art was so thorough that the Egyptian government did not require

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[228] Creswell, review of Hautecœur & Wiet, *Les mosquées du Caire*, 2 vols., in *Journal of the Royal Asiatic Society* 66 (1934): 199-203; Hautecœur, reply to Creswell, review of *Les mosquées du Caire*, in *Journal of the Royal Asiatic Society* 67 (1935): 223-228; and Wiet, review of Creswell, *Muslim architecture in Egypt*, 2 vols., in *Syria* 40 (1963): 201-208. Web addresses are given in the bibliography.

[229] Article on "Creswell, K. A. C.", in Blair & Bloom, eds., *Grove Encyclopaedia of Islamic Art* (2009). Articles are all unsigned.

> his departure from Egypt in 1956 when nearly all other French and British nationals were compelled to leave."

Creswell was indeed an extraordinary character. In a biographical obituary, R. W. Hamilton has a slightly more positive assessment:[230]

> "All who had travelled with him, who had enjoyed his high spirits or relished his often entertaining displays of inveterate prejudice, would agree that Creswell had a vein of eccentricity."

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Much has been written about the Napoleonic intervention in Egypt. Much that is positive is inevitably in French. A whole exhibition on the subject was held at the Institut du monde arabe in Paris in 2008-09. The catalogue almost ran out of words, and there were pictures galore from the *Description de l'Égypte*. There was not a word about the wind-catchers or indeed about the scientific tradition in Egypt, both of which were still alive around 1800.[231]

A 2006 exhibition at the Dahesh Museum in New York City entitled "Napoleon on the Nile: Soldiers, artists and the rediscovery of Egypt" focussed on the *Description*, as here described in reporters' jargon in the *New York Times*:[232]

> "The *Description* consisted of 23 outsized volumes, 13 entirely devoted to engravings. It laid the foundation of Egyptology, sparked the Egyptian

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230 R. W. Hamilton, "Keppel Archibald Cameron Creswell 1879-1974" (1991), p. 15.

231 See Humbert *et al.*, *Boneparte et l'Égypte – feu et lumière*, the catalogue at an exhibition held at the Institut du monde arabe, Paris, and the Musée des Beaux-Arts, Arras, in 2009. There are illustrations with wind-catchers on pp. 45, 90, 98, 122, 304, 311, 318-319, 379, but not a word on them in the text. The bibliography consists mainly of French works, but not those of the I.F.A.O., and of course not Jaubert 1995.

232 Smith, "When French savants were in Egypt's land", *New York Times*, 16.06.2006.

> Revival in design (and the long-lasting fad of Egyptomania) and helped start the colonialist ball of Orientalism rolling, you might say, toward our present predicament. In his ground-breaking 1978 book *Orientalism*, the cultural critic Edward Said referred to the *Description* as "that great collective appropriation of one culture by another"."

These ill-informed jibes link the *Description de l'Égypte* to an Orientalism about which neither Edward Said nor the *NYT* reporter knew anything serious. If Said had been better informed about orientalists than he was about 'Orientalism' we would not have needed a book like *Said and the Unsaid*. Our "present predicament" is partly a result of the fact that people have no idea what Orientalists have achieved over the past few centuries in the way of the *Unsaid*: the basic documentation, literary, linguistic and pictorial, of the history of lands and cultures that are not their own.

The problem for others is that the *Description de l'Égypte* is French. A recent Anglophone commentator on the later *Description of Egypt* by Edward Lane – see below – claimed about its Napoleonic predecessor:[233]

> "One scholar has even suggested that it (*leg*. the *Description de l'Égypte*) inspired both Edward Lane and David Roberts to visit Egypt, a preposterous canard for which there is no proof whatever. The standard clichés about Bonaparte's *Description de l'Égypte* are that it is "unique" and "unprecedented", that it "opened up the country", that it "inspired the beginning of Egyptology", that it remains "an invaluable contribution to knowledge", and that it "had enormous cultural impact". None of these claims is remotely true."

On the contrary I would claim that most of these clichés are true, with certain provisos. The French publication has certainly been most useful in re-establishing the importance of the wind-catchers of medieval Cairo. Whatever one may think of colonialist undertakings, one can still take advantage of them, be it using the *Description de l'Égypte* as a historical

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233 web.archive.org/web/20051204021357/http://weekly.ahram.org.eg/2000/503/books5.htm.

source as I have just done, or using the vast Sudan Railways trains and steamers network, as I used to do 50 years ago.

A mysterious image misinterpreted

In his splendid 1978 chapter on Islamic vernacular architecture, the Australian specialist on book history Guy Petherbridge included an image of a row of Cairene houses alongside a body of water with some pleasure-boats on it – **Pl. C16**.[234] He wrote of it:

> "Cairo impressed travellers by its multi-storey houses on the banks of the Nile, with their projecting screened balconies and wind-scoops rising from the roofs to channel the prevailing north breezes into the rooms beneath."

In 1984 King adopted this same image and wrote of it:[235]

> "The skyline of Cairo in the mid-19th (?) century viewed across the canal [*sic*] illustrated in an unidentified work. Note that the ventilators are open to a direction parallel to that of the Khalīj; but if they are correctly displayed, then the view is across the Khalīj away from the Old City [*sic*]."

His argument was that the water on which people were amusing themselves in boats was not the Nile; these must therefore be houses along the Khalīj. Never mind that the Khalīj was not wide enough for this kind of entertainment.

In 1990 the historian of Classical Art Elfriede Knauer wrote about the same image in her study of Roman wind-towers:[236]

> "King rightly [*sic*] observes that the ventilators – if the topography is correct – face in the wrong direction. I think that the mistake can be easily

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[234] Taken from Petherbridge, "Vernacular architecture – The house and society", in Michell, ed., *Architecture of the Islamic world* (1978), p. 179. No provenance is given for the image (see p. 6).

[235] King, "Architecture and astronomy", p. 98 / *Synchrony*, VIIc: 783.

[236] Knauer, "Wind-towers in Roman wall-paintings?", p. 19, n. 34.

> explained: since we have to do with an engraving, the original drawing was naturally reversed in the print [*sic*]. The fact that the wind is consistent – that is, coming toward the ventilators – is proved by the inflated sail in the foreground. This boat is heading upstream and needs the north wind, while the others drift down with the current of the canal [*sic*]."

Wrong again, because the image is an extract from a much larger engraving of the Ezbekiyya Square under flood, which happened once a year.

A closer look in the *Description de l'Égypte* reveals that this image is part of one of the three engravings in that work of the Ezbekiyya Square at flood-time.[237] This should have been obvious, not least because the people shown in the boats are French, not Egyptian! And the boats are not Egyptian anyway! The wind-catchers are facing more or less north, and the view is towards the west side of the lake.

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The *Description de l'Égypte* has been the subject of numerous studies in recent years, some of which are listed in the bibliography. Obviously the work has been of prime importance and utility in the present study, not least because it precedes most of the other pictorial sources documenting the demise of a highly significant historical architectural tradition. In 1798 the wind-catchers were still a significant feature of the Cairo skyline. And we now have evidence, in addition to two plates in the *Description* showing a Cairene sundial and a Maghribī astrolabe, to show that astronomy in medieval Cairo was arguably more advanced than it was in medieval Paris or in medieval London and Oxford – see **Ch. 13**.

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[237] Daniel, *Architectural orientations in the papyri* (20210), pp. 135-136, does not fall for any of this, taking his illustration directly from the source (*Descr. Égypte*, pl. 42).

Eusèbe de Salle, quoted at the beginning of this section, would, I think, be happy that at least this Englishman appreciates the *Description de l'Égypte*.

Artists of different nationalities after *ca*. 1800

> "The oriental scenes are strengthened by Gérôme's stoic admiration for the acceptance of life and nature by the Egyptians." Gerald Ackerman, *Gérôme* (1986), p. 46.
>
> "Attirés et fascinés eux-mêmes par les couleurs éclatantes et la lumière flamboyante du soleil, ces artistes nous livrent, au travers d'une technique picturale soit académique soit avant-gardiste – plus proche de l'Impressionnisme – harems, scènes de vie de rue, intérieurs ombragés, paysages, scènes bruyantes ou plus intimistes … . Autant de peintures colorées, inondées de soleil, étranges, cruelles, lascives, tendres, fastueuses, mystérieuses ou documentaires, qui nous attirent et nous fascinent aujourd'hui d'une manière un peu différente qu'à l'époque où les occidentaux découvraient le monde oriental, mais toujours avec la même force qu'explique ce besoin d'exotisme qui nous caractérise." / "The Orientalists had a passion for the brilliance of colors and the flamboyance of sun light which they reproduced in a strictly academic style or taking avant-gardiste liberties with that style. They portrayed harems, street scenes, cool and dark interiors, landscapes, scenes of clamour or, secretiveness. Their works make use of vivid colors, they show floods of sunlight, or, to the contrary they opt for the strange, the lascivious, the tender, the ostentatious, the mysterious or the descriptive. Their art draws us like a magnet although our fascination is experienced, today, in a totally different way. The unifying factor which travels through the ages is the need to experience the unknown or the exotic, which remains one of the West's remarkable characteristics." Extracts from two versions of the blurb about the exhibition "Merveilles de l'Orientalisme" held at the Musée Regards de Provence in Marseille in 2016, at www.museeregardsdeprovence.com/exposition/merveilles-de-lorientalisme. (Note that the harems come first.)

> “(The term Orientalism) for many people is highly charged, bringing to mind patronising 19th-century oil paintings by colonialist artists depicting a version of life in the Middle East that often did not exist. … … The exhibition will acknowledge that some 19th-century Orientalist works blurred the lines between fantasy and reality by showing a stereotyped view of the east, whether that was barbaric behaviour or a scene of people sitting around drinking coffee with no cares or work to do. But there is a much longer and richer history to be explored, say curators. The show will trace the origins of Orientalism to the 1500s and features 16th-century western paintings of Ottoman sultans. There will be important works by some of the leading Orientalist painters of the 19th century, such as Eugène Delacroix, John Frederick Lewis and Frederick Arthur Bridgman.” Mark Brown, “Major exhibition aims to show Orientalism in a different light and its legacy today: British Museum to explore Islamic world's impact on western art”, *The Guardian* 16.07.2019.

The reader must not expect detailed accounts of the lives and fortunes and Egyptian sojourns of the artists mentioned here. He or she may wish to consult the *Benezit Dictionary of Artists*, of which the first version was published in French in 1911-1923 by Emmanuel Bénézit (1854-1920) and a team of specialists. The latest editions in French and English in 14 volumes contain more than 20,000 pages with over 170,000 entries. Most of the French orientalist painters are featured in the *Dictionnaire des orientalistes de langue française* edited by François Pouillon and published in 2008. I have not included references to that splendid work. For an overview of the earliest European publications there is a little catalogue of an exhibition held at the Institut du Monde Arabe in Paris in 1989.[238]

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238 *Paris IMA 1989 Exhibition Catalogue*: *Premières publications européennes sur la civilisation arabo-islamique* (1989).

Whole books and monographs and exhibition catalogues have been dedicated to some of these artists by art historians and devotees of orientalist art. For biographical details on other artists, I have been grateful to be able to draw on Wikipedia, and for this I make no apologies. There has been considerable interest shown in European travellers to Egypt, and particularly in individual travelling artists, if mainly on a national level.[239] Here we are interested in the wind-catchers as they are depicted rather than the artists and the paintings themselves. The majority of the "orientalist" images presented in **Part II** can be found on the internet, but finding them from scratch is another matter.

In many of the hundreds of images of 18th- and 19th-century Cairo, not a single wind-catcher is shown. Some of these are rather surprising, not to say disappointing for the present endeavour. For example, the Italian-German artist Luigi Mayer (1755–1803) was an Italian-German artist and one of the earliest and most important late 18th-century European painters of the Ottoman Empire. He has left us numerous splendid views of Cairo such as his "Grand Cairo with Mourad Beg's Palace", "Mamaluks exercising in the Square of Mourad Bey's Palace", and "Mosque of Four Hundred Pillars".[240] The same holds a century later with, for example, the American artist Louis Comfort Tiffany (1848-1933) and his "On the Way between Old and New Cairo, Citadel Mosque of Mohammed Ali, and Tombs of the Mamelukes" (1872). In this study I shall not mention other artists who shunned the wind-catchers for aesthetic or other reasons.

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239 See, for example, Paul Starkey & Janet Starkey, eds., *Travellers in Egypt* (1998), and the informative comments about a 1995 conference at Durham University Oriental Museum entitled "Travellers in Egypt" at www.astene.o—*—rg.uk/wp-content/uploads/2014/05/BULLETIN-1.pdf; and Mercedes Volait, ed., *Le Caire dessiné et photographié au XIX^e^ siéc*le, (2013).

240 On the first see Warner, *Monuments of Historic Cairo* (2005), pl. 12 on p. 37.

Louis-François Cassas

Louis-François Cassas (1756-1827) was a distinguished French landscape painter, sculptor, architect, archaeologist and antiquary. He visited Egypt for three months in 1785, and drew the antiquities of Alexandria, the pyramids of Giza and the mosques of Cairo. His *Voyage Pittoresque ...*, a monumental pictorial account of his travels in the Middle East, with close to 200 plates, was commissioned by the French ambassador to the Ottoman court and was published in 1799.

This work contains at least one image relevant to our study – **Pls. D1-2**. This is a "side view" of the Mosque of Sultan Ḥasan, showing the houses close to it on the western side. Numerous wind-catchers are shown, fine constructions to be sure, all large and all fitted with substantial roofs double the length of standard wind-catcher roofs. These, if correctly represented, which I doubt, could offer much shade to any who would sit under them, and indeed some men are standing and sitting on a rooftop nearby, probably in prayer, since they are facing a little to the right of the direction perpendicular to the back axis of the wind-catcher, which would correspond to the *qibla* of the astronomers – see below. Notice, however, that the house on whose roof they are standing is facing that direction also.[241] These very large 'suspension'-type roofs would not fair well in high winds.

Another engraving by Cassas is preserved in the German Archaeological Institute in Cairo. It is his 1796 engraving *Wedding procession along the*

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241 Cassas, *Voyage pittoresque de la Syrie, de la Phoenicie, de la Palestine et de la Basse-Egypte, gravées sur les dessins et sous la direction de L.-F. Cassas, peintre* (1799). See www.abebooks.fr/edition-originale/Voyage-Pittoresque-Syrie-Ph—*—oenicie-Palestine-Basse-Egypte/19310413886/bd. Also, the exhibition catalogue Gilet & Westfehling, eds., *Im Banne der Sphinx – Louis-François Cassas, 1756-1827* (1994).

Bayn al-Qaṣrayn,[242] that is, the main axis of the medieval city. Looking beyond the main scene behind the man on horseback there are two *bādahanj*es. – **Pl. D2a**. They should be open not overlooking the street but rather parallel to it, facing north away from the viewer. However, they would then admittedly be less interesting from an artist's perspective.

Cassas' engraving *Voyage pittoresque* shows the procession of the Ottoman governor at his arrival in Cairo with an impressive display of costume and material culture – **Pl. D2b**. However, Doris Behrens-Abouseif, who has studied some of Cassas' works, thinks that the architectural background is based on "a pastiche of sketches rather than a faithful depiction of the urban surroundings".[243] Worthy of mention, in any case, is the very prominent *bādahanj* on top of a four- or five-storey house next to a religious complex. Its orientation is not worthy of comment if this is a stage-setting.

Again, Doris Behrens-Abouseif also illustrates Cassas' pencil study of various minarets in Cairo including "two minarets on the right side that belong to the mosque of al-Ḥākim near the northern gate of Bāb al-Futūḥ and three other minarets that cannot be associated with specific buildings, although their style is obviously Mamluk" – **Pl. D2c**. For our present purposes there are two pairs of substantial wind-catchers to be seen very clearly, one pair by the minaret on the left and another pair between the two minarets in the middle. The fact that each pair faces different directions results from the fact that the minarets were originally viewed from different perspectives.

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242 Warner, *Monuments of historic Cairo* (2004), p. 30, fig. 24.

243 Behrens-Abouseif, "Between Istanbul and Cairo: Louis François Cassas and the panoramic perspective" (2010), p. 4 & figs. 2-3 on p. 11.

A general view over the City with the Citadel on the left and the Sultan Ḥasan Mosque on the right does feature a few wind-catchers over by the Mosque.[244]

Nicolas-Jacques Conté

Nicolas-Jacques Conté (1755-1805) was a French painter, balloonist, army officer, chemist, and inventor of the modern pencil.[245] He was employed as an engineer with Napoleon's army in Egypt. His first balloon prepared for the French New Year celebrations on 22 September 1798 exploded,[246] and a second one ascended over Azbekiyya Square apparently watched by 100,000 people.

Conté has left us a splendid coloured picture of the Sultan Ḥasan Mosque and its environs, probably achieved in the 1790s – **Pl. D5**. Several wind-catchers are shown on the nearby domestic architecture. The most prominent one on the left faces toward the right, and the most prominent one on the right faces toward the left. It is still nice to have them all. The picture is a tribute to Conté's new line of pencils, developed by him on account of a blockade on graphite from Great Britain. (Trade sanctions tend to promote initiative on the part of victims, a fact which some people tend to forget these days.)

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[244] Gilet, "Cassas und der Orient" (1989), pl. 346 on p. 286. I have not found a satisfactory image of this painting, which is preserved in the Musée des Beaux Arts, Tours.

[245] On the context see Patrice Bret, "Instruments of Knowledge and Power in a Colonial Context: Scientific Instruments during the French Occupation of Egypt" (2019), p. 223.

[246] The French Republican Calendar, which was in use from 1793 to 1805, celebrated New Year's Day at the autumnal equinox. Others prefer to associate it with the winter solstice or the vernal equinox.

An aquarelle by Conté shows a farmer with his plough drawn by two cows.[247] In the village behind them a solitary wind-catcher is visible: **Pl. D17**.

Dominique Vivant Denon

> (Denon) said that he had crossed "a country that is, apart from its name, entirely unknown to Europeans, and therefore everything was worth describing". (*Voyages dans la Basse et la Haute Egypte pendant les campagnes de Bonaparte en 1798 et 1799*, 1817).

Vivant Denon (1747-1825) was a French artist, writer, diplomat, author, and archaeologist.[248] He was appointed as the first Director of the Musée du Louvre by Napoleon after the Egyptian campaign of 1798-1801.

Denon has left us two sketches relevant to the present study. First, a view of the lake of Ezbekiyya at full moon which shows the silhouettes of numerous wind-catchers on the houses on the city side of the lake – **Pl. D3**. Second, an unidentified gate close to the Nile which has a substantial wind-catcher on top of it – see **Pl. D4**. The device apparently serves a single room below with a large *mashrabiyya.* The picture somehow does not look like a Cairo scene.

Henry Salt

Henry Salt (1780-1827) was an English artist, traveller, collector of antiquities, diplomat, and Egyptologist, who was British Consul General in Egypt from 1816 to his death.[249] A somewhat fanciful view over the city

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247 Humbert *et al*., *Boneparte et l'Égypte* (2008)*,* p. 90.

248 Denon, *Voyage dans la Basse et la Haute Égypte pendant les campagnes du Général Bonaparte*, 2016 edn.

249 Ackerman, *Les orientalistes de l'école britannique* (1991), pp. 262-265.

of Cairo behind the Sultan Ḥasan Mosque shows not a single wind-catcher and is disappointing for our purposes: **Pl. F1**.

Prosper Marilhat

Prosper Georges-Antoine Marilhat (1811-1847) was a French orientalist painter. In 1831 he was invited by the botanist and explorer Charles von Hügel to accompany him on a lengthy exhibition to Greece, the Near East and India. Marilhat did not travel beyond Alexandria, and stayed between that city and Cairo for 18 months, earning money by painting portraits, but also preparing ten albums of sketches, which he would later use for his paintings. Many of his most successful works were based on these sketches. Alas, he contracted syphilis and died at the age of 36.

Marilhat's exceptional painting of the square of al-Ezbekiyya concentrates on two splendid and enormous sycamore fig trees (*ficus sicomorus*, Egyptian colloquial *gimmeez*) – **Pl. D5a**.[250] The Cairo-based French freelance reporter and commentator on topics of consequence, Louise Sarant,[251] observes that such trees

> "can grow to reach a height of 20-25 meters, a trunk girth of six meters, and possesses a dense crown of spreading branches which offer a delightful shade up to a few hundred square meters."

The sycamore fig tree was the "tree of love" of the Ancient Egyptians, and the trees were still abundant two hundred years ago but their numbers diminished with disappearance of the fig wasp (*ceratosolen arabicus*) which pollinated them. Louise Sarant mentions that the Egyptian Ministry of Environment does not have plans to salvage the tree. The most famous

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250 www.mutualart.com/Artwork/Vue-de-la-Place-de-L-Esbekieh-et-du-Quar/06FA4300F44F9590. Several images are available on the internet, all blurred.

251 Louise Sarant, "Endangered species: Egypt's tree of love", *Egypt Independent*, 15.03.2011, also article https://en.wikipedia.org/wiki/Ficus_sycomorus.

of these trees is that at Matareya, now a suburb of Greater Cairo; according to legend, the infant Jesus and his parents took shelter. Marilhat was obviously a lover of trees. Even his Cairo street scene shows a solitary and unexpected palm tree.

(I too remember with pleasure a sycamore fig tree in Ezbekiyya Park: in the 1970s my wife and I were wandering through the Park and I perceived a *roba vecchia* man, a seller of used clothing. Hanging from a low branch of the tree, above his table covered with his wares, I espied a tweed jacket hanging from a branch. I tried it on, it fit, I bought it, and I wore it for many years, not only in Cairo but in New York. It always reminded me of the sycamore fig trees of Ezbekiyya.)

For our purposes, Marilhat's Ezbekiya scene is of interest because three parts of the city are shown in the distance on the left and on the right, and in between the two trees. In the central part we can see a single wind-catcher, and on the right several. His Cairo street scene – **Pl. D5a** – shows some strange constructions on the roof of a house to the right. Whether the open door-frame – memories of Aleppo in **Pl. P6** – and other bits and pieces have anything to do with ventilation is unclear.[252]

Marilhat's painting of the ruins of the 10th-century Mosque of al-Ḥākim[253] –**Pl. D5b** – gives an idea of the state of some of the major mosques in Cairo before they were restored (and, in this particular case, according to some, ruined again by the Bohras in the late 20th century).

Adrien Dauzats

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[252] www.wikiwand.com/en/Prosper_Marilhat.

[253] On the mosque see Bloom, "The Mosque of al-Hakim in Cairo" (1983). On these images see https://commons.wikimedia.org/wiki/File:Marilhat_Pros—*—per_Georges_Antoine_Ruines_De_La_Mosquee_Du_Calife_Hakem_Au_Caire.jpg . Also, https://en.—*—kipedia.org/wiki/Al-Hakim_Mosque#/media/File:Mos—*—que_of_El-Hakim_(1878)_-_TIMEA.jpg

Adrien Dauzats (1804-1868) was a French painter who visited Cairo in 1831. He has left us a remarkable painting of the main entrance to the al-Azhar Mosque.[254] On the roof above the entrance is a single wind-catcher in a state of collapse, and on the balcony nearby is a final resting place for wooden frames of defunct wind-catchers – **Pl. D16.**

Guillaume Lejean

Guillaume Le Jean or Lejean (1824-1871) was a Breton of French citizenship who was an explorer and ethnographer. He wrote an imposing number of articles on his travels, which were published in *Revue des deux mondes*. He also wrote about slavery in Egypt and Turkey (1870) after the American War of Independence. In his *Le tour du monde* (1868) he published *inter alia* a woodcut of the port of Qusair viewed from the Red Sea coast – **Pl. E8**.[255] This is of interest to us because several wind-catchers are shown on what is perhaps a fort (?), their hoods appropriately open toward the right, that is, in a northerly direction.

Joseph-Philibert Girault de Prangey

The Frenchman Joseph-Philibert Girault de Prangey (1804-1892) is better-known as a photographer than an artist – see **Ch. 7** below. However, an engraving based on one of his daguerreotypes is of particular interest. The view is over part of Cairo after the fire of 1838, taken from a Christian convent in the European quarter of El-Mouski – **Pl. D6**.[256] Various wind-catchers are still standing after the fire, one taller than average and another three times the standard width. Note that they are facing two principal

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254 Humbert *et al*., *Boneparte et l'Égypte* (2008), pp. 310-311, pl. 268.

255 https://depositphotos.com/13330088/stock-photo-al-qusair.html, also image-photo/al-qusair-old-view-egypt-created-82851520.

256 Girault de Prangey, *Panorama d'Égypte et de Nubie,* 1841, from Stephen C. Pinson, ed., *Monumental journey – The Daguerreotypes of Girault de Prangey*, 2019, p. 18.

directions, the one perpendicular to the other; this is, of course, absurd. But the wood-cut was supposedly made from a daguerreotype!

Jean-Léon Gérôme

> "This beautiful painting shows men at prayer on the roof of one of the mosques or madrasas of the old Mamluk part of Cairo. The time is the *maghrib* (prayer), the sun has just set, and the muezzins, visible on the two closest minarets, have performed the call to prayer. The setting crescent moon, appropriately inclined to the horizon, is just visible behind the men, so that a new month has just begun. Obviously the men at prayer are supposed to be standing in the *qibla*, facing towards Mecca. (But the wind-catchers nearby are open toward the same direction, when they should be facing perpendicular to the *qibla*.) There are some problems." D. A. King, "Aspects of practical astronomy in mosques and monasteries", Pt. VIII of *In Synchrony with the Heavens*, vol. 1 (2004), pp. 847-880, esp. p. 861.

> "Another Orientalist who captured Egypt's sites was Jean-Léon Gérôme (1824–1904), a French painter who made six trips to Cairo between 1856 and 1880. During these trips he took some of the earliest photographs of Egypt, collected artifacts, and drew sketches of the country and its people, material from which he later was to create nearly 250 paintings back in his studio in France. Because his works were done while away from Egypt, Gérôme had to reconstruct scenes based on his sketches and photographs. For his backdrops, he occasionally employed studio objects, furnishings, and models dressed in costumes from a collection assembled by his brother-in-law, Albert Goupil, a renowned collector of Islamic art. Gérôme's oeuvre portrays characters and scenes he considered to be representative of life in Egypt. Striving for authenticity, he paid great attention to details, and as a result his paintings have an almost photographic quality to them. His scenes, however, are based on the Egypt of his recollections, and in drawing his paintings he took great liberty to interpret Egyptian culture to suit the colors and exotic atmosphere in his paintings. This meant altering reality in favor of aesthetics, an inclination

common in many Orientalist painters. There are factual errors in some of his works, like his "Prayer on the Rooftops of Cairo," where the worshipers are drawn facing north rather than toward the qibla ... ." Nezar Al Sayyad, *Cairo – Histories of a city* (2011), pp. 192-193. (No reason is given why the author thinks that the men at prayer are facing north.)

Several paintings by the brilliant and influential master Jean-Léon Gérôme (1824–1904) are relevant to our study. In 1856, Gérôme visited Egypt for the first time, and again in 1862, 1868, 1869, 1871, 1874 and 1880. For the following discussion of certain paintings I have once again used the splendid 1986 book on and catalogue of Gérôme's works by the American art historian Gerald Ackerman (1928-2016).[257]

My own encounter with these in the 1980s led to my using one of the most spectacular of Gérôme's paintings on the cover of my 2004 history of the regulation of the prayer-times in Islam (تاريخ علم الميقات). This "Prayer on the House-Tops" (cat., no. 152) shows men at prayer on the roofs of several houses flanked by minarets features two wind-catchers, both apparently open on each side – **Pl. D7**. It is a composite painting. The men are praying in the same direction that the openings of the wind-catchers are facing. This is not good. The men should be facing the *qibla* at roughly east south-east. The buildings below them are oriented in this direction. The ventilators should be facing the perpendicular direction of north north-east. The crescent moon, appropriately inclined to the horizon, is visible behind the right shoulders of the men but it should be somewhere north of west. In brief, all is not well. I have published a detailed critical analysis of the composition of this painting elsewhere.[258]

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257 Ackerman, *Gérôme* (1986), pp. 67 & 216-217 (no. 152; pp. 66 & 218-219 (nos. 163-164); and pp. 222-223 (nos. 173 & 173B).

258 King, *In Synchrony with the Heavens*, vol. 1 (2004), front cover; V: "On the role of the muezzin and *muwaqqit* in medieval Islamic society", pp. 336 & 339; and

On 30 April 2019 at *The Orientalist Sale* at Sotheby's of London a copy from a private collection of the same scene by Gérôme himself was auctioned for £735,000 sterling. In addition to various minor modifications it displays three wind-catchers on the left (in the Hamburg painting one is almost concealed by two men standing in front of it) as well as numerous ones in the distance (in the Hamburg painting all of these are concealed by heat haze) – **Pl. D7a**.[259]

Gérôme's painting "Le muezzin" / "The muezzin" (no. 163, replica in no. 164) shows three strange contraptions on a nearby roof and two large *malqaf*s on a distant roof. His "Un muezzin appelant du haut du minaret les fidèles à la prière" / "A muezzin on the minaret calling the faithful to prayer" (no. 273) shows over a dozen *malqaf*s on the roofs below the minaret - **Pl. D10**.

Two other views of Cairo by Gérôme show several wind-catchers and serve more as reminders that the golden era of the Cairo wind-catchers was gone – **Pls. D8-9**.

Now perhaps the best-known painting of Gérôme – **Pl. D12** – at least amongst French enthusiasts, displays Napoleon on a fine steed overlooking the city (no. 173). There are dozens of wind-catchers visible, and beneath the front of the horse one can observe a house-roof with several such devices and women hanging out laundry and long-legged cats looking for pigeons. In an oil sketch of the same scene (no. 173B) the same wind-catchers are shown without the women and the cats – **Pl. D12a**.

Pascal Coste

VIII: "Aspects of practical astronomy in mosques and monasteries", pp. 847-880, esp. pp. 860-862.

[259] www.sothebys.com/en/auctions/ecatalogue/2019/the-orientalist-sale-l19100/lot.22.html.

A print of the Sultan Ḥasan Mosque from *ca*. 1820 by Pascal Coste (1787–1879) shows the back of a wind-catcher on a nearby house – **Pl. D18**.[260] It looks as though the left-hand side is open, as indeed it should be. Coste's album of prints is otherwise disappointing for our purposes.

Robert Hay

Robert Hay (1799-1863) was a Scottish explorer, antiquarian, and early Egyptologist.[261] Service in the Navy brought him to Alexandria in 1818 and this visit, coupled with his reading of the works of the Italian Egyptologist Belzoni,[262] inspired him to return to Egypt in 1824 and spend 10 years there. His splendid view of the Palace of Sharīf Bey to the right of the Square of Ezbekiyya – **Pl. F6** – shows three wind-catchers on the palace and three more visible to the left. All are open on each side. Another work by Hay features the slave market near al-Azhar Mosque.[263] Some curious structures are shown on the buildings behind – **Pl. F7**. Yet another

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260 Coste, *Architecture arabe ou Monuments du Kaire* (1839), pl. 26.

Jaubert, "Capteurs de vents" (1995), p. 179, n. 38, states that this image (Coste, pl. 26) shows two wind-catchers facing different directions ("anormalement positionné dans des orientations contraires"), which he attributes to the carelessness with which orientations, such as positions of the sun, are represented, as opposed to the accuracy afforded such features as *mashrabiyya*s and window-shutters. Unfortunately, we are talking about two different images.

261 Nicoliades, "Robert Hay, Illustrations of Cairo, ... , 1840" (n.d.).

262 See, for example, Clayton, "A pioneer Egyptologist: Giovanni Baptista Belzoni, 1778-1823" (1998).

263 Botte, "Des européens au marché aux esclaves" (2016), fig. 1, from http://wellcomeimages.org (where it is listed as "Lithograph by J.C. Bourne after O.B. Carter and H. Warren, *ca*. 1860").

image by Hay is of the houses along the shore of the Birkat al-Fīl – not a single *bādahanj* is shown.[264]

Louis Amable Crapelet

Louis Amable Crapelet (1822-1867) was a French water-colour painter. He went to Egypt in 1852, and ascended the Nile as far as the 3rd cataract and returned to France in 1854. He exhibited mainly views of Egypt, rather than Tunisia and Algeria, which he had also visited, at the Salons between 1849 and 1866, as well as the occasional Italian and Provençal landscape.

A painting by Crapelet that is particularly interesting – not only for our purposes – is preserved in the Musée Regards de Provence in Marseille – **Pl. D22**.[265] Its joyful and colourful aspect full of human interest is set at the port of Būlāq. There are people in a market, coming and going, and others waiting with some camels near the water. More people are standing and sitting on a boat. In the town behind we see the minaret and dome of a mosque, and a series of houses along the water-front.

One of these houses demands our attention. It has two storeys and an extra room at the top. On the roof of this room is a rather prominent *bādahanj*. It is simple but one can see the tattered-looking ends of the palm-fronds on the rectangular cover, which is supported by two vertical posts. The western side is not blocked off. It is obvious that Crapelet knew what he was painting, and the *bādahanj* features prominently in the middle of his

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264 Reproduced in Byliski, "Darb ibn al-Baba: A Quarter in Mamluk Cairo in the Light of Waqf Documents" (1994), p. 220, fig. 6. The enormous European-looking houses at the centre are not quite what one might expect around the Birkat al-Fīl.

265 On two other paintings by Crapelet which are in the same "people and camels and trees" tradition – also **Pl. D22** – see Sarah Guest Perry's extensive blog "Nearly forgotten but glorious art, envisionings and historical oddments from the back corners of the internet", at https://sarahbguestperry.blog/category/watercolor/.

charming painting. It is open facing the Nile, whereas it should be facing north, toward the observer. No matter!

In the literature I have consulted I have found no serious information on Crapelet and no serious mention of his paintings. There was apparently no catalogue for the 2016 Marseille exhibition in which the Crapelet Būlāq painting featured.

David Roberts

> "The 19th century was a time when many European artists and writers traveled to Egypt to explore its ancient sites. One of the earliest travelers, who produced some of the most renowned artworks depicting Egypt and Cairo from that period, was the artist David Roberts (1796-1864). Roberts was forty-two when he arrived in Egypt as a member of the Royal Academy with the specific mission of producing a body of visual work documenting Egypt's cities and archaeological sites. Purportedly the first British artist to "discover" Egypt, Roberts's intent was to fill in gaps left by the French in their *Description de L'Égypte*. Prior to his arrival, Roberts had read everything he could about Egypt, including the works of Edward William Lane. The artwork that Roberts brought back to England was one of the most interesting collections produced on the region. It was also one of the last to document Egypt before the advent of photography. About a quarter of the works in Roberts's portfolio depict Cairo's street life, its people, and its Islamic monuments. ... ... In his diary he describes the painstaking process of gaining access to sites, and of drawing in the crowded streets in the unforgiving heat, surrounded, at times, by unwelcoming crowds." Nezar Al Sayyad, *Cairo – Histories of a city* (2011), p. 190.

The Scots artist David Roberts (1796-1864) visited Egypt and Palestine during 1838-39 and has left us with a spectacular array of the lithograph

prints.[266] Amongst these are two which concern us here. The first shows the religious complex in spectacular red and white with the Pyramids in the background – **Pls. F2-3**. In the foreground next to one of the two minarets we see a bevy of wind-catchers, the larger one in the foreground in better shape than its mate. On the former the wood on the top is falling apart, but it is clear that the western side is open. On the latter only the frame survives and a fence has been erected around the top of the shaft. The second print is a view from Sayyida Zaynab toward the desert of Suez showing two wind-catchers viewed from the back, one large and one small, the former clearly open on the western side – **Pls. F4-5**.

Friedrich Maximilian Hessemer

Friedrich Maximilian Hessemer (1800-1860) was a Frankfurt architect who proclaimed that if reincarnation was real, he would have been in his previous existence an architect in the European Middle Ages or an architect in Ancient Egypt.[267] After 30 years as teacher of architecture, mathematics, perspective and drawing at the Städel Art Institute in Frankfurt, he went travelling in Europe and beyond, spending 1829-30 in Egypt. His vivid imagination is apparent in his paintings of mosques and city-views. The one which concerns us most is a splendid aquarelle of the Mosque of Abu ʻl-ʿIlā in Bulaq – **Pl. E1**. We see the back of a substantial wind-catcher to the right of the dome of the Mosque. The left-hand (western) side is open, as it should be according to medieval prescriptions. This is the one painting that was <u>not</u> on display at an exhibition on

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266 See Guiterman & Llewellyn eds., *David Roberts 1796-1864* (1986), also the article https://en.wikipedia.org/wiki/David_Roberts_(painter).

267 Eichenauer, ed., *Friedrich Maximilian Hessemer (1800-1860): Ein Frankfurter Baumeister in Ägypten* (2001), esp. pp. 22-25, 40-43, 53-67, and catalogue pp. 226-227 & 232-233 (nos. 61, 67-68), and Bideault, " "Mein Fritz geht nach Aegypten!" Friedrich Maximilian Hessemer sur les traces de l'arc brisé au Caire" (2013).

Hessemer held in Frankfurt in 2001. Two other paintings of Hessemer's that were exhibited in Frankfurt show the Mosque in Jirja with a wind-catcher and a city-view towards the Mosque of Sultan Ḥasan with several such devices (nos. 61 & 67).

Jules Bourgoin

> "(Bourgoin) trained as an architect at the *École des beaux-arts* in Paris (though non-practicing), he spent several years, between 1863 and 1884, in the Near East, mainly in Egypt. Confronted by a world of forms and compositions unknown to him, he became fascinated by the way artists and craftsmen arranged geometrical forms, from the simplest to the most complex, interweaving their lines endlessly. Bourgoin, who had wanted to be a mathematician, understood that there was an underlying system to these compositions, and his driving ambition became to explain, through many concepts and drawings, the rules of the patterns." Maryse Bideault, "Sketching the intricate life of Jules Bourgoin" (2013).

If I were to start to write about Jules Bourgoin (1838-1908), I should need another chapter for this monograph, for Bourgoin was the first Westerner to document scientifically the richness of Islamic geometric design.[268] He therefore deserves our undying gratitude. Bourgoin spent most of the period 1863-84 in Cairo and recorded the geometric designs he found in every historical building. Any mathematician and any art historian and anyone fascinated by Islamic art will appreciate his achievement. The French art historian and specialist on Bourgoin, Maryse Bideault, has rightly claimed that Bourgoin has not received the recognition he deserves.

In one of his architectural sketches Bourgoin represents a historic Cairene house on which is substantial *mashrabiyya*, which was the purpose of his

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[268] See the bibliography under Bourgoin where various studies by Maryse Bideault are also listed.

exercise. However, stuck on the roof is another object, a wind-catcher, which also combines decorative art with functionality – **Pl. D16**. Bourgoin's sketch confirms that wind-catchers might be decorated, especially if they can be seen from below. See **Pls. Q10-12** for three later examples of decorated wind-scoops.

I have often wondered what would have happened had I pursued Islamic geometric design (which everybody likes) rather than pursuing Islamic astronomy (which very few people care about) and *bādahanj*es (your opinion is important).

Frank Dillon

Frank Dillon (1823-1909) was a British landscape painter who visited Cairo four times between the 1850s and 1870s. He produced a remarkable group of paintings of Cairo houses, so true to life that they are difficult to distinguish from modern digitalized images.[269] The paintings treat mainly of domestic interiors, but two of them are different outside scenes entitled "The house of Mameluke / Memlook Radnau (?) Beg" and dated 1870 – **Pl. F13**. The name should be رضوان, Riḍwān. In the first painting, to the right of his palace there is a very tall *bādahanj* together with a smaller one partly hidden by a palm-tree. In the second one, the house to the left of the palace sports a rather rickety-looking *bādahanj* open on both sides.

The palace itself (Jaubert #47), dating from 1650, was already in ruins 25 years ago, but the French scholars who documented the remains found the grille of one *bādahanj* in the western *īwān* and suspected two more in large

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[269] See http://victorian-era.org/frank-dillon-biography.html, and Llewellen, "Frank Dillon and Victorian pictures of old Cairo houses" (1984) (not seen), and *eadem*, "Two interpretations of Islamic domestic interiors in Cairo: J. F. Lewis and Frank Dillon" (1998), esp. pp. 154-155, on Dillon's attempt to document the palaces of Riḍwān Beg and the 'house of the Muftī' "before they crumbled completely".

room and the second *qāʿa* of the east wing which was inaccessible to them.[270]

Dillon made five paintings of this palace alone. As the scholar who has done most to draw attention to his works, Briony Llewellyn, observes:

> "By the 1870s the modernisation of (Cairo) meant that old houses were actually being destroyed and Dillon was aware that he was recording buildings and architectural decoration that would soon no longer exist. He later became active among a group of people committed to the preservation of Islamic buildings in Cairo, and displayed his watercolours during at least one meeting held at the Royal Institute of British Architects to discuss Arab houses in Cairo."

I hope some of the *anti-orientalistes* get to read this.

John Frederick Lewis

John Frederick Lewis (1804-1876) was a British painter who lived in Cairo, it is said, in grand style, between 1841 and 1851. I have looked at dozens of his paintings and sketches of domestic interiors from his Cairo stay, but none featured what I was looking for, namely, a group of people sitting in front of a grille from which there was obviously emerging a current of cool, refreshing air. But his paintings may still well repay careful scrutiny.[271] As Briony Llewellyn has remarked:

> "Since the publication of Edward Said's seminal book, *Orientalism: Western Conceptions of the Orient*, in 1978, modern criticism has been less willing to accept Lewis's paintings at face value, and his Orientalist subject matter has at times been seen as Western fantasy, as politically subversive and as the embodiment of colonialist paternalism. More

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[270] References in Jaubert, "Capteurs de vents" (1995), p. 200 (#47).

[271] Llewellen, "Two interpretations of Islamic domestic interiors in Cairo: J. F. Lewis and Frank Dillon" (1998), and *eadem*, "Drawing from Life: The orientalist watercolours of J. F. Lewis" in *Cornucopia – The Magazine for Connoisseurs of Turkey*, issue 45 date?).

> recently, some careful critical analysis has recognised that the complexities of Lewis's compositions defy the simplicities of the Saidian tunnel vision and he has been acknowledged as one of the most intriguing of all Orientalist artists."

I hope some of the *anti-orientalistes* get to read this too. Criticism of Lewis is still rampant. Thus the scholar Faredah Mohsen al-Murahhem, in her paper "The 19th-century Western travellers' conception of the *ḥarīm*" (2011):

> "This paper examines 19th-century Western travellers' understanding of the *ḥarīm*. Focusing in particular on visual depictions, it investigates the misconception and misrepresentation of the *ḥarīm* in Orientalists' paintings and Western culture, using the work of John Frederick Lewis as the main case study."

The author could well read al-Tanūkhī's account of the drunken *qāḍī* in the *ḥarīm* presented in **Ch. 4**. Or for a better understanding, look at the *ḥarīm* over its history of more than 1,000 years, as illustrated by the short article "Ḥarīm" in the *Encyclopedia of Islam*, 2nd edn., with a useful bibliography. Various more recent studies are grouped together at the end of Section V of the bibliography.

Jan-Baptist Huysmans

The Belgian painter Jan-Baptist Huysmans (1826-1906) studied at the Royal Academy of Fine Arts in Antwerp during 1843-1849. From 1856 onwards he travelled widely and visited Greece, Turkey, Syria, Palestine, Egypt and Algeria. "He was clearly fascinated and sensitive to the intricacies of local costume, accessory, and custom, as is shown in his sketchbooks, studies, paintings and written accounts of these travels."[272] What concerns us is his painting "Evening prayer", dating from 1859, which is clearly inspired by Gérôme's "Prayer on the rooftops" – compare

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[272] Wikipedia article *s.v.*; see also https://i.pinimg.com/originals/21/96/52/—*—219652b6d32bd21970910701f2dabe5e.jpg.

Pls. E7 & D7. Here a group of men, women and children stand respectfully behind a man kneeling and bowing down in prayer. On the roofs of the houses in the background are three wind-catchers, the one on the right clearly no longer functional. One can see all of the struts of the two on the right. Huysman's attention to detail is truly remarkable!

Eugène Poitou

The Frenchman Eugène Poitou (1815-1880), advisor to the Court of Anger, spent the winter of 1857 in Egypt and authored an illustrated book *Un hiver en Égypte*. Two of his illustrations in the 1881 edition merit our attention, one of Ezbekiyya lake and the other of a city gate – **Pl. D13**.[273] Some 10 wind-catchers in the right foreground appear to have both sides open, and the one near the gate has both sides closed.

Robert Duncan

An unidentified artist named Robert Duncan[274] presented an image of a street in a Coptic district of the city with a single *bādahanj* on one of the roofs and the opening overlooking the street – **Pl. F7**. The implication is that the street is perpendicular to the main axis of the old city.

Bernhard Fiedler

A remarkable painting by the German artist Bernhard Fiedler (1816-1904) shows the view from the Citadel toward the Mosque of Sultan Ḥasan and features the numerous wind-catchers that preceded those shown in early photographs – **Pl. E5**.[275] The work was completed in 1853-54 during a

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273 Poitou, *Un hiver en Égypte* (1881 edn.), available on the internet.

274 Perhaps in Ackerman, *Les orientalistes de l'école britannique* (1991).

275 On Fiedler see, for a start, https://de.wikipedia.org/wiki/Bernhard_Fiedler. On this painting see https://commons.wikimedia.org/wiki/File:Bernhard_Fiedler_-

study-tour of Egypt and Palestine. A black-and-white version was published by the German Egyptologist Georg Ebers in 1878-80 in his *Aegypten in Bild und Wort* – see below. Another painting of Fiedler's shows a street in Cairo with a minaret and there is also a wind-catcher on the right – **Pl. E6**.[276]

Edward W. Lane

Edward William Lane (1801-1876) was a British orientalist who spent the years 1833-35 in Cairo.[277] In his *Manners and customs of the modern Egyptians*, first published in 1836, and his *Description of Egypt,* published for the first time in the year 2000, he included some modest images of Cairo scenes with numerous wind-catchers in the background – **Pls. F9-12**. These images are presented without comment; it is as if he took the *malqaf*s for granted. As we have already seen, in his *Manners & customs of the modern Egyptians*, Lane explains why: they were all over the place.

The Exposition universelle in Paris 1867

The ruler of Egypt, the Khedive Ismail Pasha (*reg*. 1863-1879), took advantage of the spectacular Exposition universelle in Paris in 1867 to assert his country's global stature. The elaborate exhibit on Egypt included reconstructions of four buildings – and Ancient Egyptian temple, a *selamlik* or men's reception pavilion, an 'okel' or *wikāla* or guesthouse, and a stable. The impressive exhibition catalogue of over 400 pages was prepared by the Polish writer and activist Charles Edmond Chojecki

_Ansicht_von_Kairo_-_2986_-_Kunsthistorisches_Museum.jpg, also Ebers, *Aegypten in Bild und Wort* (1879-80).

276 www.lempertz.com/en/catalogues/lot/934-1/63-bernhard-fiedler.html.

277 See Ahmed, *Edward W. Lane – his life and work* (1978), the standard work, and numerous other writings. His unpublished *Description of Egypt* is now finally available thanks to the labours of Jason Thompson.

(1822-1899) and included a detailed sociological and statistical survey of Egypt.[278] The *wikāla* features a fine *bādahanj* on its roof – **Pls. D20-21**.

Arthur Rhoné

Arthur Rhoné (1836-1910) was a wealthy amateur French Arabist and Egyptologist, known for his efforts to prevent the "vandalism", often in the name of "restoration" or "improvement", of monuments in Cairo, and also those in Paris. (The new layout of central Paris resulted from the sacrifice of the medieval city.) For the latter he published in 1889 his *Réflexions sur l'enlaidissement progressif des villes qu'on embellit* (*Reflections on the progressive disfiguration of cities by improvements*).[279]

Rhoné spent the years 1879-1882 in Egypt, and was partly responsible for pressuring the Khedive to establish the Comité de Conservation des Monuments de l'Art Arabe (Commission for Conservation of Monuments of Arab Art). In 1881 he wrote:

> "the city of Cairo was still intact, at least in the sense that its monuments continued to fall quietly into ruin following the eternal way of the Orient; at least nothing was attempted in the way of works called 'improvement' and 'restoration'."

In his *L'Égypte à petites journées : Le Caire d'autrefois*, published in 1910, Rhoné did not mention our wind-catchers. He did refer to the Palace

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[278] Charles Edmond, *L'Égypte à l'Exposition universelle de 1867* (1867), and Alia Nour, "Egyptian-French cultural encounters at the Paris Exposition universelle of 1867" (2017); the *wikāla* is illustrated in Edmond, p. 202, and Nour, p. 36, fig. 5. See also Humbert *et al*., *Boneparte et l'Égypte* (2008), p. 379.

On the Exposition see also Mitchell, *Colonizing Egypt* (1988), pp. 1-33. Egyptian visitors were not impressed that the Egyptian street-scenes were deliberately made to appear dirty and that the 'mosque' was but a façade.

[279] On Rhoné see the article in Wikipedia and also Volait, "Arthur-Ali Rhoné (1836-1910) – Du Caire ancien au Vieux-Paris ou le patrimoine au prisme de l'érudition dilettante" (2006).

of Alfī Beg, and presented a drawing with its immense *bādahanj* (perhaps the largest in Cairene history?), noting that it has become the Hotel of "Sheepsherd".[280]

Georg Ebers

The German Egyptologist Georg Ebers (1837-1898) published in 1878-80 a two-volume set entitled *Aegypten in Bild und Wort. Dargestellt von unseren ersten Künstlern*.[281] An English version *Egypt: Descriptive, Historical, Picturesque* followed in 1892. I have not seen this work and have found only one relevant engraving from it on the internet. This is an engraving of the view from the Citadel over the Sultan Ḥasan Mosque, which turns out to be derived from the painting by Bernhard Fiedler – see above. The numerous wind-catchers on the buildings in the foreground are more than what we shall find a few decades later in early photographs of the same scene.

Otto Pilny

Otto Pilny was a prolific Swiss painter who has left us dozens of scenes of life in Egypt. Many of his paintings feature encounters in the desert. Pilny was born in Česke Budejoviče (Budweis) in what is now Czechia, studied in Prague before living in Vienna and ultimately settled in Zurich, where he died in 1936. He first visited Egypt in 1875 and stayed for two years, spending time travelling with Bedouin nomads. In 1889 he visited Egypt again and was honoured by King ʿAbbās II.

The painting which concerns us now bears a loose title "Cairo market square" – **Pl. E10**. It was completed in 1893. A colourful, lifelike market scene in a small square with an imposing mosque features a wind-catcher on a distant tall building. What is important here is not that we see a wind-

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280 Rhoné, *L'Égypte à petites journées: Le Caire d'autrefois* (1910), pp. 104-105.

281 Ebers, *Aegypten in Bild und Wort* (1878-80).

catcher, but rather that Pilny was so conversant with the Cairo of his time that he could not resist including a wind-catcher, if only on the very edge of his charming painting. On 24.04.2018 it was auctioned at Sotheby's of London in the "Orientalist Sale".[282]

Fabio Fabbi

The Italian orientalist painter Fabio Fabbi (1861-1946) devoted much time and energy to representing *mashrabiyya*s of various kinds – see **Pl. N6** – as well as his human subjects, but I have found no *malqaf*s depicted in the background of his Cairo scenes.[283]

Some later orientalist painters

Rudolf Ernst (1854-1932) was an Austro-French painter, printmaker and ceramics painter who is best known for his orientalist motifs. Ludwig Deutsch (1855–1935) was an Austrian painter who settled in Paris and became a noted orientalist artist. None of the dozens of paintings of their renderings of Cairo scenes or imaginings that can be seen on the internet offers a view of wind-catchers. The concerns of the artists lie in other directions. With these prolific artists we abandon the search for materials relevant to our study, and turn to another medium.

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Not a single one of the paintings that we have mentioned has ever been used by a historian of Islamic architecture to show what the wind-catchers of Cairo used to look like a century or two ago. The same holds for the historical photographs that we shall present next.

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[282] www.sothebys.com/en/auctions/ecatalogue/2018/the-orientalist-sale-l18100/lot.51.html

[283] On Italian orientalist painters see Juler, *Les Orientalistes de l'École italienne* (1987).

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In conclusion, I express the hope that those who do not like orientalist paintings because they think that they denigrate the local population can be just a little grateful to the painters who have left us these few images. For they reveal, amongst other things, how clever the local population of Cairo was in the old days, and how they kept cool by natural means in the days before air-conditioning.

7 — The wind-catchers in early European photography

"(After the invention of photography in 1837), numerous photographers came to the Middle East from Europe and America, native Middle Easterners took up the craft, and local studios proliferated. Driven by scholarly, religious, romantic, or commercial interests (or any combinations thereof), these photographers produced and disseminated millions of photographic images of the Middle East during the last half of the nineteenth century. This vast visual record, which covers a wide array of topics and interests, provides a valuable resource for the study of the Middle East. ... ... Despite the potential value of early photography to the field of Middle Eastern studies, its importance has yet to be fully recognized, since scholars of many disciplines concerned with this region are largely unaware of the wealth of visual documentation available ... ." Paul Chevedden, "Making light of everything: Early photography of the Middle East and current photomania" (1984), p. 152.

"Surprisingly, the invention of photography in 1839 did little to contribute to a greater authenticity of painterly and photographic representations of the "Orient" by artists, Western military officials, technocrats, and travelers. Instead, photographs were frequently staged and embellished to appeal to the Western imagination." Nancy Demerdash, "Orientalism" (2015).

"My country is no longer in Africa; we are now part of Europe. It is therefore natural for us to abandon our former ways and to adopt a new system adapted to our social conditions." Khedive Ismail in 1879, recorded at https://en.wikipedia.org/wiki/Isma%27il_Pasha.

"The irony of the situation was that Egypt had embarked on its development schemes to secure independence from Ottoman and European domination. Yet with each new concession, the government of Egypt made itself more vulnerable to European encroachment." Eugene Rogan, *The Arabs*, Penguin, 2011, p. 101,

quoted *ibid*.)

A wealth of material

The series of European photographers who captured scenes in Egypt in the late 19th and early 20th century provide us with another valuable corpus of documentation for the few remaining wind-catchers of Cairo. Not surprisingly, none of these photos is “staged” or “embellished”. The photographers themselves have been captured in a very useful encyclopaedia of 19th-century photography and photographers by John Hannavy, published in 2007.[284] Not only does this work contain biographical and technical information about individual photographers and their work, but there is also a section “Egypt and Palestine”. For French photographers we have the very valuable overview by the architecture historian Maryse Bideault, which surveys the lives and legacies of close to a dozen individuals, identifying where their works are located, and presenting numerous examples of their productions.[285]

Also, the American historian of the Near East, Paul Chevedden, in an important article on early photography of the Middle East (1984), rich in insights and in bibliography, examines several cases where early photos contradict the claims of architecture specialists who did not know these photos existed, particularly in the case of architecture that was destroyed after the photos were taken.[286]

This is precisely the case with the many available 19th- and early-20th-century photos showing wind-catchers. My purpose here is only to

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[284] Hannavy, *Encyclopedia of 19th-Century Photography* (2007).

[285] Maryse Bideault, *L’iconographie du Caire dans les collections patrimoniales françaises* (2010). See also Irini Apostolou, ”Photographes français et locaux en Orient méditerranéen au xix^e^ siècle” (2013).

[286] Chevedden, “Making light of everything: Early photography of the Middle East and current photomania” (1984).

document the sub-group of Western photographers whose work shows some of the few remaining wind-catchers of historical Cairo. We are not primarily concerned with artistic merit here, but rather with what we can learn from these images about the subject at hand. Also, we are not concerned with national(istic) achievements, so the following photographers are not grouped together according to national origins (as they are, for convenience, in **Part II**).

Photographers who captured the Cairene wind-catchers

Girault de Prangey

The Frenchman Joseph-Philibert Girault de Prangey (1804-1892) was, according to some, the first photographer of the Middle East.[287] One of his remarkable Daguerreotype photos is of the main courtyard of the al-Azhar Mosque, datable to 1843. Of interest to the present study are the four *malqaf*s on the roof of the south-west side of the Mosque, appropriately shown open facing north-east – **Pl. D15**.[288] Also there is a larger unidentifiable structure with a triangular façade by the side of the minaret above the main entrance, behind the wooden balcony which looks over the

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[287] Hannavy, *Encyclopedia*, pp. 397-398; article "De Prangey ... " by Helène Bocard; also Girault de Prangey, *Panorama d'Égypte et de Nubie,* 1841, from Stephen C. Pinson, ed., *Monumental journey – The Daguerreotypes of Girault de Prangey*, 2019, p. 18.

[288] www.wdl.org/en/item/14760/view/1/21/, also www.watercolourworld.o—*––rg/painting/22-cour-de-la-mosquée-el-ahzar-au-kaire-tww011c62. The painting is included in Prisse d'Avennes, *L'art arabe d'après les monuments du Kaire* (1869-1877), with this item accessible at www.wdl.org/en/item/14760/view/1/21/.

See, most recently, Pinson, ed., *Monumental Journey – Daguerreotypes of Girault de Prangey* (2019). I am most grateful to my friend Nora Kennedy, one of the contributors, for a copy of this work, presented at the memorial celebration for Mary Helen Kennedy in Doylestown PA in July 2019.

courtyard. Could this be another *malqaf*? Only the closed triangular side of the contraption can be seen. Could the opening be blocked by the minaret? At least it is facing the right direction.

A print of a view over part of Cairo after the fire of 1838, taken from a Christian convent in the European quarter of El-Mouski, was prepared from a wood engraving by Girault de Prangey – see already **Ch. 6** and now **Pl. D6**. Various wind-catchers are still standing after the fire, one taller than average and another three times the standard width. Note that they are facing two principal directions, the one perpendicular to the other. This is, of course, absurd, but the wood-cut was supposedly made from a daguerreotype!

A photograph attributed to Girault de Prangey – **Pl. H1** – shows a curious contraption on the roof of a house near a mosque. Could this be a *malqaf*? It is facing away from the viewer and the top appears to slope, being covered with a certain amount of detritus.

As I write these lines in May, 2019, there is an exhibition at the Metropolitan Museum of Art in New York, entitled *Monumental Journey – Daguerreotypes of Girault de Prangey*.

M. Martinet

M. Martinet was apparently a late-19th-century French photographer. He has left us two images of the Cairo of his time, one of which may feature a wind-catcher, and the other needs to be interpreted – see **Pl. H4**.[289]

Beniamino Facchinelli

The Italian photographer Beniamino Facchinelli (1839-1895) has left us three images relevant to the present study – **Pls. G1-3**. First, in a lively scene of a small mosque and unusually real people, we can see the top of

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[289] www.getty.edu/art/collection/artists/2664/m-martinet-french-active-19th-century/. Martinet is not in Hannavy, *Encyclopedia*.

the roof of a wind-catcher at the centre of the photo, partly hidden by a wooden structure. The top resembles the one which survives on the al-Jawhara Palace on the Cairo Citadel. Second, on Facchinelli's photo of the Mosque of Sultan Qā'it Bāy there are three simple wind-catchers on the roofs of houses adjacent to the Mosque.[290] Third, his photo of the *maqʿad* of the house of Sultan Qā'it Bāy taken from the inner courtyard shows a wind-catcher on the roof.[291]

Félix Bonfils

Félix Bonfils (1831-1885) was a French photographer and one of the first commercial photographers to produce images of the Near East on a large scale. Several unsigned photos attributed to him serve our present purpose – **Pls. H5-9**.

Francis Frith

Various photographs of Cairo taken around 1858 by the English photographer and publisher Francis Frith (1822-1898) appear in his album *Egypt, Sinai, and Jerusalem* (1860).[292] Particularly his views from the Citadel show dozens of *malqaf*s on buildings known as Bāb al-ʿAzab,

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290 Facchinelli, *Raccolta artistica di fotografie sull'architettura araba, ornati ecc. dal XII° al XIII° secolo* (1887). Also, Volait, "Beniamino Facchinelli (1829-1895)". Facchinelli is not in Hannavy, *Encyclopedia* – a serious omission.

291 Seif, "The lens of Biniamino Facchinelli" (2013), p. 204.

292 Hannavy, *Encyclopedia of Nineteenth-Century Photography* (2013 edn.), pp. 558-560, also Frith, *Egypt, Sinai, and Jerusalem* (1860). See the articles "Frith, Francis" by Kathleen Stewart Howe and "Frith & Co." by Maxim Leonid Weintraub in Hannavy, *Encyclopedia*, 560-562 & 558-560, and Williams, "A 19th-century photographer: Francis Frith" (1998). The website Perry, "33 rare photos of Egypt by Francis Frith" (2019), includes not a single image of Cairo. See further http://luna.wustl.edu:8180/luna/servlet/detail/19Cent~16~7~155640~123461.

workshops that were used mainly for military purposes – **Pls. L1-3**. Several other early photos show similar shots.

Jakob August Lorent

Jakob August Lorent was born in Charleston, South Carolina, in 1884, of German immigrant parents. As a child he came to Mannheim to stay with his wealthy foster-father and eventually did a doctorate in botany at the University of Heidelberg. He began travelling to the Near East in 1842 and learned Arabic during several visits. His interest in botany inspired him to become a photographer of renown for both plants and architecture; he published a volume of photos *Egypten, Alhambra, Tlemsen, Algier* in 1861. He died in Merano in 1884.[293]

Lorent has left us a spectacular photo of a view over the Eastern Cemetery toward to al-Azhar Mosque on the left to the Qalāwūn and Barqūq Mosques on the right – **Pls. J1-J3**. Dozens of wind-catchers are to be seen; their distinctive sloping roofs are easily identifiable. One large one on the right-hand side sits on the roof of a mosque. This having been said, they all give the impression that they would have to be replaced more often than might be convenient.

Lorent also photographed a spectacular array of *mashrabiyya*s on a four-storey housing complex in Cairo – **Pl. N6a**. There are no wind-catchers visible, but rather awnings erected on wooden supports on the roof to create additional private recreational space, maybe also for sleeping under the stars.

Lorent expressed his fear of the increasing Western influence in the Near East rather eloquently:

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[293] Hannavy, *Encyclopedia*, pp. 872-874 (not seen). These images are from Lorent, *Egypten ...* (1861), is taken from Volkoff, *1000 Jahre Kairo* (1984), pl. 3, and www.pinterest.com/pin/14003448827260242/. See also http://www.eslam.de/b––*—egriffe/l/lorent_jakob_august.htm.

> "Die Tage sind nicht ferne, in welchen man im Morgenlande nichts mehr als die Unvollkommenheit des Abendlandes wiederfinden wird." / "The days are not far ahead when people in the Near East will find nothing more than the imperfection of the Western world."

He could never have dreamt what the future would bring.

Wilhelm Hammerschmidt

Wilhelm Hammerschmidt (1830-1869), a Berlin photographer, opened an atelier in Cairo in 1864.[294] He has provided us with a very important photograph taken *ca*. 1858 from the Citadel and showing the dome of the Mosque of the *amīr* Qawṣūn which was constructed in 1329/30 – **Pl. J4**. The Mosque is surrounded by houses featuring *bādahanj*es. But the importance of the photo also lies in the fact that this monument, one of the most important 14th-century mosques built in Cairo was pulled down in 1873 to make way for the Boulevard Muḥammad ʿAlī, the present-day Shāriʿ al-Qalʿa.[295]

When my late friend, Michael Meinecke, the leading authority on Mamluk architecture, published a study of this Mosque in 1976/77, he was unable to comment on its unusual dome because he was unaware of the existence of this photo. As pointed out by Paul Chevedden, the dome reflects the same Tabrīzī influence which Michael documented inside the Mosque.

(Willem de Famars Testas)

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[294] On Hammerschmidt see Hannavy, *Encyclopedia*, p. 633, article by Rolf Sachsse, also Hammerschmidt, *Monuments de l'Égypte ancienne et moderne* (1860). See also www.invaluable.com and http://archiveswest.orbiscascade.org/ar—*—k:/80444/xv44810/pdf for dozens of his photos.

[295] Chevedden, "Early photography in the Middle East" (1984), pp. 160, 162, on the historical importance of this photograph.

I have not found any images relevant to the present study in the *œuvre* of the Dutch painter/photographer Willem de Famars Testas (1834-1896).[296]

Francis Bedford

Francis Bedford (1815-1894) was the first photographer to accompany a British royal tour. In 1862, when he was asked by Queen Victoria to travel with the Prince of Wales, the future King Edward VII, Bedford was already an accomplished and respected professional photographer, with two earlier royal commissions already completed.[297]

Bedford accompanied the Prince of Wales[298] on a flying visit to Egypt in 1862. His iconic photo of the recently completed Mosque of Muḥammad ʿAlī is well known, but what is of greater relevance to the present study is his panorama of Cairo – **Pls. K1-2**. Taken from the Minaret of the Mosque of Ibn Ṭūlūn toward the Citadel, the photo reveals wind-catchers galore, most of which look rather fragile. This is the only image, pictorial or photographic, that has come to my attention in which there is a sensible statement about the wind-catchers in the caption. Here we read:

> "The flat, leaning structures on the rooftops of many of the houses are makeshift wind-tunnels, designed to capture cooling breezes and send them down into the buildings below."

For "makeshift" perhaps read "renewable"; they have been (halfway) "makeshift" for close to a thousand years. On the other hand, some, but not all, do look a bit makeshift.

Émile Béchard

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296 Not in Hannavy, *Encyclopedia*.

297 Hannavy, *Encyclopedia*, pp. 134-136. For his panorama of Cairo see www.rct.uk/collection/search#/67/collection/2581387/panorama-of-cairo-egypt.

298 In 2019 an ignorant foreign potentate in a tweet referred to the present bearer of this title as "the Prince of Whales".

Émile Béchard (1840-1891) was a French photographer who worked in Cairo from 1869 to 1873, associated with Hippolyte Délié in his studio located at Mousky street, in the district of Azbekiya. Amongst his first photographs from 1870 is a panoramic view over the city from the Citadel with the Pyramids in the distance on the left and the Mosque of Ibn Ṭūlūn on the right – **Pl. H8a**.[299] This features *malqaf*s galore in all directions. He also captured the many *malqaf*s below the Citadel in the same year – **Pl. H8b**.[300]

The 68 albumen prints contained in the album "Oriental Studies" by Béchard do not, alas, feature our wind-catchers.[301]

In 1874, Béchard published a detailed album of 61 photographs of the first buildings in the new quarter which the Khedive Ismail (*reg*. 1830-1695) had started to create in Cairo, modelled on new Parisian housing developments. As Mercedes Volait, specialist on historical French visitors to Cairo, has written:[302]

> "Béchard's album is an extraordinarily unique visual and also documentary source for the genesis of modern Cairo. It stands as the photographic counterpart of the map made by the civil engineer Pierre Grand that same year, at a 1/4000th scale. Taken together, these two exceptional documents allow us to obtain an extremely accurate idea of the process of the native transformation of a great Middle-Eastern capital, before its colonial occupation by the British in 1882."

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299 https://www.flickr.com/photos/photohistorytimeline/24874173114.

300 www.gazette-drouot.com/lots/5310401.

301 American University in Cairo, "Philip Maritz Collection of Émile Béchard's photographs", at http://digitalcollections.aucegypt.edu/cdm/landingpage/col—*—lection/p15795coll16.

302 Volait, "Émile Béchard – Le nouveau Caire photographié 1874", n.d., at https://heritage.bnf.fr/bibliothequesorient/en/emile-bechard-new-cairo-article.

It is somewhat ironic that Khedive Ismail (1830-1895), the Egyptian ruler who was largely responsible for the modernization of Cairo, was born in the Musāfirkhāne Palace.

The Zangaki brothers

The Greek brothers Constantin and Georges Zangaki were photographers active in Egypt (based in Port Said) between 1870 and 1900 who specialised in recording sites of Ancient Egypt. Fortunately, they also took a fine shot of the Citadel of Cairo from below – **Pl. L6**. Some Ottoman-era *malqaf*s are visible (يعني) from this side too, just.

J. Pascal Sébah

J. Pascal Sébah (1830-1910) was a Turkish photographer whose view over the city reveals a diminished number of wind-catchers but still several in a distant corner on the upper left – **Pl. M1**.

Of particular interest is Sébah's first view over the rooftops near the al-Azhar Mosque – **Pl. M2**. To the right of the minarets we see one full wind-catcher and three partially visible. In the lower right-hand corner of the photo is a close-up of part of the closed east side of a wind-catcher, and it is here that Sébah has written his name and identified his subject.[303] Surely Sébah is responsible for another view of the al-Azhar minarets in which two wind-catchers feature in the foreground – **Pl. M3**. Unlike what we see in most images of the al-Azhar, the *bādahanj*es here are in good shape; indeed, they have clearly recently been replaced. What is perhaps surprising is the fact that the materials used for the roof and the east side of each *bādahanj* are apparently so insubstantial. Yet another photo of a similar scene shows a total of six wind-catchers on the al-Azhar roof, with yet another in the distance – **Pl. M4**.

303 Nasser Rabbat, "Al-Azhar Mosque" (1996), p. 60.

Sébah may also be responsible for a photo taken from the Citadel – **Pl. L3**.[304]

Gabriel Lekegian

The Armenian photographer Gabriel Lekegian (b. *ca*. 1850, 1880 painting in Constantinople, active in Cairo from 1880 till 1920s) apparently left thousands of images of Cairo.[305] At least four merit our attention – **Pls. M5-M8**. The first shows minarets of the al-Azhar Mosque with three *malqaf*s on the roof in front, one falling apart – a slightly later photo by K. A. C. Creswell tries to avoid the rickety structures. The second is a view of houses along the street of Bāb al-Shaʿriyya. The third is a scene in Bulaq with not a single wind-catcher visible. Were there any on the roofs of the buildings lining the street? It should be remembered that they would not necessarily have been aligned with the street, but they would be aligned with their back axes facing winter sunrise. Certainly the myth of *bādahanj*es on all of the houses along the Canal is dispelled by his fourth photo.

S. Rappoport

In the remarkable *History of Egypt* from 330 B.C. to "the present" with over 1200 coloured plates and illustrations, the author of volume 12, S. Rappoport, presents himself as "Doctor of Philosophy, Basel" and "Member of the École Langues Orientales, Paris; Russian, German, French Orientalist and Philologist". The work was published in London by The Grolier Society Publishers in 1905.[306] I have not been able to find out much about the

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304 Sébah, *Comparative views of Egypt*, 1870, pl. 31, also on AntiquePho—*—toWorld.com.

305 No entry in Hannavy, *Encyclopedia*, but remark (p. 1035) that he was from Jerusalem. See http://lusadaran.org/artists/gabriel-lekegian/.

306 Rappoport, *History of Egypt* (vol. 12, 1905), pl. 190.

author. His surname is an Ashkenazi name from the Hebrew רפפורט, meaning from the Rapa family in Porto Mantova, Italy.

Although wind-catchers are not mentioned in the text we find a charming sketch entitled "The mulqufs on the houses of modern Egypt" – **Pl. E9**. The view is from the Nile looking east towards the Citadel. Otherwise, this does not look like any view of Cairo as seen from the River, and the Citadel looks more like the Alhambra Hotel in Granada. Nevertheless, there are '*mulquf*s' galore: a total of six can be seen on the houses amidst the minarets.

Auguste Léon

Auguste Léon (1857-1942) was a French photographer who in 1909 started working for the project "Les Archives de la Planète" ("Archives of the Planet") of the French philanthropist Albert Kahn (1860-1940), a photographic endeavour to document world cultures and monuments. In 1914 Léon made a visit to Cairo and Upper Egypt.[308] His photo of the necropolis of Qā'it Bāy shows numerous rather simple wind-catchers around the mausolea of Princesses Tughāy and Tulbāy – **Pl. H9**.

A postcard of the roof of the al-Azhar Mosque taken about the end of the 19th century and signed "L.L."[309] can hardly be due to Lehnert and Landrock – see below – and the signature has also been interpreted as "Léon & Lévy" – see **Pl. N3**.

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[308] On Léon's visit to Egypt see www.arcgis.com/apps/MapTour/ind—*—ex.html?appid=c45bb9b9a70f4833b12f418a36a6ea03 and also https://artblart.co—*—m/tag/auguste-leon-egypt-giza/. Neither of these sites feature the photo which concerns us. It is reproduced in Bammate, *Cités de l'Islam* (1987), mentioned in Jaubert, "Capteurs de vents" (1995), p. 211, n. 64 (wrong page cited). Jaubert wrote that the wind-catchers in this photo were "*très nombreux*", which is a modest exaggeration.

[309] http://digitalcollections.aucegypt.edu/cdm/compoundobject/collection/p—*––15795coll21/id/1849/rec/37.

Lehnert & Landrock

Rudolf Franz Lehnert (1878-1948) was an Austro-Hungarian photographer. Ernst Heinrich Landrock (1878-1966) was his German friend and business partner.[310] They established studios successively in Tunis, Munich, Leipzig and Cairo. Their shop in Cairo, "the German bookshop", since 1924 at number 36 on Abd-Al-Khalik Sarwat Street, was until recently a meeting-place for many people who cared about this or that. Lehnert's dozens of photos of Cairo were of high quality, but architecture was not his major interest.

Walter Mittelholzer

Walter Mittelholzer (1894-1937) was born in St. Gallen as the son of a baker. He earned his private pilot's license in 1917, and in 1918 he completed his instruction as a military pilot. From 1920 Mittelholzer was the director and head pilot of Ad Astra Aero which later became Swissair. One of his major undertakings and many adventures was the first North-South flight across Africa 1926/27, taking 77 days. Throughout his life he published many books of aerial photographs and marketed his expeditions through films and the media as well. He died in a climbing accident in Austrian Alps.

One of Mittelholzer's many remarkable photos was taken at 800 meters above Cairo, centred on the Mosque of Ibn Ṭūlūn and over as far as the Mosque of Muḥammad ʿAlī on the Citadel – **Pl. J5**.[311] Most of the

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310 Hannavy, *Encyclopedia*, p. 1032. See also www.egy.com/people/99-01-21.php and www.pikdo.online/tag/lehnertandlandrock/ and ww.dw.com/en/the-dangerous-job-of-selling-books-in-cairo/a-17053566.

311 www.theguardian.com/cities/gallery/2017/jul/05/1930s-cities-from-the-air-aerial-photographs-walter-mittelholzer-in-pictures#img-1, from Bildarchiv, ETH-Bibliothek, Zurich.

*bādahanj*es are gone, the only ones that one can still find are just below the Citadel.

Louis Hautecœur and Gaston Wiet

We have already mentioned the two volumes of *Les mosquées du Caire*, published in 1932 by Louis Hautecœur and Gaston Wiet. The volume of 30 plans and 250 plates contains nothing that would indicate that wind-catchers had ever been a prominent feature of the city landscape.

Gaston Wiet's little book *The Mosques of Cairo*, published in 1966, with 64 photographs by Albert Shoucair, is a charming introduction to the monumental architecture of Cairo, and a guide to its principal examples.[312] Of course, the photos include no wind-catchers. They would not have featured on most of the architecture illustrated, and those that did, are long gone.

The authors of the *Palaces et maisons*

References to wind-catchers are to be found here and there in the publications of French scholars who documented the palaces and houses of medieval Cairo. But there is a problem. For example, Edmond Pauty, in his "Les palais et les maisons d'époque musulmane au Caire" (1933), wrote about the Musāfirkhāne Palace but did not even mention the enormous wind-catcher. He did present the print from the *Description de l'Égypte* of the Palace of ʿUthmān Bey with its even more imposing wind-catcher – **Pl. C8** – but ignored the latter in his description of the former.[313] The later volumes of the same series do more justice to the occasional wind-catchers encountered, and Olivier Jaubert's 1995 publication is a supplement to these.

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[312] Wiet, *The Mosques of Cairo* (1966).

[313] Pauty, "Les palais et les maisons du Caire" (1933), pp. 59-60 & 69-70.

K. A. C. Creswell

We have already mentioned the British scholar, K. A. C. Creswell (1879-1974), based in Cairo, who published *Early Muslim Architecture*, 2 vols., (1940); *A short account of early Muslim architecture* (1958); and *The Muslim Architecture of Egypt*, 2 vols. (1952-59). Creswell documented wind-catchers wherever he found them or traces of them, but in all, he discussed just half a dozen of them.[314]

- Mosque of al-Ṣāliḥ Ṭalā'iʿ, 1160 (Jaubert #17): I, pp. 284, 285, pl. 105-d and 108-d
- al-Kāmiliyya Madrasa, 1129 (Jaubert #20): II, pp. 80, 82, fig, 37
- Mausoleum of Sultan Qalāwūn, 1284-85 (Jaubert #21): II, pl. 64
- Madrasa of Sultan al-Nāṣir Muḥammad ibn Qalāwūn, 1295-1304 (Jaubert #22): II, pl. 235, fig. 137
- Madrasa of the *amīr*s Sanjar and Salār al-Jawlī, 1303-1304 (Jaubert #23): II, p. 244, fig 140
- *Khānqāh* and mausoleum of Baybars al-Jāshankir, 1306-1310 (Jaubert #24): II, p. 252, fig. 142

Unfortunately, Creswell did/could not know the proper medieval name of the wind-catchers so he used the modern expression *malqaf*. If he had known the term *bādahanj* this might have aroused more interest. See below – "What's in a name?" in **Ch. 11**. Creswell, it is said, refused to learn (colloquial Egyptian) Arabic, apparently out of a disdain for the contemporary culture whose historical architecture he was so passionately studying.[315] He continuously cited various relevant Arabic historical sources, such as the Egyptian historian al-Maqrīzī, whose urban history of Cairo has to this day not found a translator. Any foreigner functioning

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314 Creswell, *The Muslim architecture of Egypt* (1952-59), I, pp. 45, 226, 284-285, and |II, pp. 244-245 & index *sub malqaf* II, p. 291

315 Rabbat, "The medieval link: Maqrizi's *Khitat* and modern narratives of Cairo" (2005), p. 36.

seriously in the history of Muslim Egypt has to know or learn written Arabic, modern and/or classical, and the Egyptian dialect, and it was probably the latter that Creswell ignored.

In any case, the *malqaf*s first documented by Creswell were, of course, taken up by Olivier Jaubert.

The 1969 Cairo conference

The elusive proceedings of the important International Colloquium on the history of Cairo held in Cairo in 1969, the first of its kind to combine the forces of historians, historians of art and architecture, specialists in urban history, and more, mentioned *malqaf*s some four times, but not seriously.[316]

Oleg Volkoff

The popular book by the Soviet Russian writer Oleg V. Volkoff (1900-1996) to celebrate the millenary of Cairo was published in French as *Le Caire 969–1969. Histoire de la ville des mille et une nuits* (1971) and in German as *1000 Jahre Kairo. Die Geschichte einer verzaubernden Stadt* (1984).[317] The introductions to these editions, respectively by the then Director of the Institut Français d'Archéologie orientale in Cairo and by the then mayor of Cairo's twin city Stuttgart, almost apologize for publishing a non-scholarly book (meaning without scholarly footnotes and documentation), albeit one of great charm. From our point of view, Oleg Volkoff shines over most other authors of books on historical Cairo in first realizing the importance of the Cairo wind-catchers, and second in

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316 André Raymond & J. Michael Rogers & Magdi Wahba, eds., *Colloque international sur l'histoire du Caire (27 mars - 5 avril 1969*) (1974).

317 Volkoff, *Le Caire 969–1969. Histoire de la ville des mille et une nuits* (1971) and *1000 Jahre Kairo. Die Geschichte einer verzaubernden Stadt* (1984). The quote is translated from p. 139 of the German version.

including relevant photographs not found in any other publications, which mainly feature images from the *Description de l'Égypte*.[318]

Our author has a paragraph on the wind-catchers in his section on Cairene houses:

> "Over every house in Cairo there yawned the opening of the famous *malqaf*. Leo Africanus ... . Prosper Alpino describes it more precisely ... . Open toward the north, the *malqaf* is the indispensable addition to every, even the most modest house. It captures the cool breeze from the north in order to lead it into the interior of the houses, and plays the same role as the ventilation funnels (German: *Lüfter*) of modern ships."

As noted above, the quote from Leo Africanus is problematic.

I have not seen Volkoff's 1972 illustrated book on Russian travellers to Egypt.[319]

Friedrich Ragette

Friedrich Ragette is a Vienna-born architect who has taught for 30 years in the US. His book on traditional domestic architecture in the Arab world has the merit of providing a broad overview of the subject in 300 pages with ample illustrations, a rich glossary and an extensive bibliography.[320] He includes several pages on ventilation techniques, with no discussion of the historical situation in Cairo but at least with the usual sketches of the complex of *Qāʿa* of Muḥibb al-Dīn al-Muwaqqiʿ also known as the *Qāʿa* of ʿUthmān Katkhudā from 1350 (Jaubert #27) and of its formidable wind-

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318 German version, figs. on pp. 156-157, 179, 190-191, 206-207, 210-211; and photo no. 4 in the collection "Kairo 1850".

319 Volkoff, *Voyageurs russes en Égypte* (1972).

320 Ragette, *Traditional domestic architecture of the Arab region* (2004/2012), pp. 87-90.

catcher, the latter sketch from an unpublished German article on "the Arab house".[321]

Gianni Ferrari

We conclude this section with a quote from Gianni Ferrari, an Italian engineer with a passion for the theory and practice of sundial-construction. In 2011 Ferrari published a book on Islamic sundials, which well displays both the richness of Islamic gnomonics and his own dedication to the subject.[322] In addition to presenting numerous examples of sundials by Muslim craftsmen, Ferrari even mentioned the different kinds of tables produced by Muslim astronomers for over a millennium – I cannot think of any other writer who has even listed them in last few decades. These include, of course, tables for marking hyperbolic hour-curves on horizontal and vertical sundials, from early 9th-century Baghdad to various Ottoman-era examples. But what concerns us here is his reference to **the table for orienting the wind-catcher** in the Cairo corpus of tables for timekeeping by the sun and regulating the times of prayer (**Chs. 13 & 17**). Ferrari's comments are also unique in the modern literature:

> "(Tavole) per il calcolo dell'orientamento dei ventilatori. Già durante il medioevo molte case in Persia, Egitto e altri paesi arabi, avevano grandi torri 'acchiappa vento' il cui scopo era quello di convogliare all'interno della casa l'aria e quindi di rinfrescare i locali adibiti ad abitazione. Al Cairo, come è testimoniato anche in un manoscritto del 1200, invece delle torri 'acchiappa vento' vennero create sul tetto delle particolari strutture, spesso a forma di alti camini, con una apertura rivolta esattamente verso il Nord o verso la direzione del vento dominante, dette 'ventilatori' o *malqaf*, strutture ancora oggi sono realizzate nelle moderne abitazioni." / "Tables

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321 Čejka, *Das arabische Haus*, unpublished manuscript, Münster (not seen).

322 Ferrari, *Le meridiane dell'antico Islam – Il tempo nella civiltà islamica* (2011), pp. 528-529, esp. n. 5.

> for calculating [finding] the orientation of 'ventilators'. Already during the medieval period many houses in Iran, Egypt and other Arab countries [? in the medieval period?] had large towers or wind-catchers whose purpose was to collect air (and lead it) to the inside of the house and then to freshen the rooms in the dwelling. In Cairo, as is also testified in a manuscript [text] from 1200, instead of these wind-catcher towers, (the ventilators) were erected on the roofs of particular buildings, frequently like tall chimneys [?], with an opening turned exactly towards the north [not quite!] or toward the direction of the predominant wind [it's not so simple!], and these 'ventilators' or *malqaf*s [as they are called in modern Arabic], such structures are still today [?] constructed [not in Cairo!] on modern houses."

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One reason why we do not always see wind-catchers in early modern representations of Cairo is that they are admittedly ungainly, especially when they are in a state of collapse. The selection of house-types from 19th-century Cairo in Richard Ettinghausen's influential 1976 study "The man-made setting" does not show any wind-catchers, even though the views of Cairo roof-tops and illustrations of house-types in the *Description de l'Égypte* all show wind-catchers galore.[323]

The above excerpts and also the illustrations should be sufficient to demonstrate that the wind-catchers were a prominent feature of medieval Cairo from Fatimid times into the late Ottoman period. May the materials presented here serve to prevent the wind-catchers from being ignored from now on, even though much of modern Cairo has inevitably been built with almost total disregard for traditional green architectural features. The reader may well ask: how could such a common feature of medieval Cairene architecture have escaped serious notice in the modern literature?

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323 Ettinghausen, "The man-made setting" (1976), p. 92. See already King, "Architecture and astronomy" (1984), p. 99, n. 7 / *Synchrony*, VIIb: 783, n. 9.

8 — Selected wind-catchers in medieval Cairo

The few wind-catchers which do survive in Cairo today are comparatively late Ottoman constructions. A dozen or so of these were listed by Alexandre Lézine in 1971.[324] A total of some 50 from Islamic Cairo, including a very few that survive to this day and others identifiable from architectural plans and early paintings and photographs, were listed by Olivier Jaubert in 1995, to whose study the reader must turn for more information. The reader should keep in mind that over the centuries hundreds upon hundreds of wind-catchers graced the buildings of medieval Cairo. And since most were made of wood, they had to be repaired on a regular basis and occasionally replaced or eventually removed.

Some individual wind-catchers of Cairo (selected)

Fortunately, several of the surviving or documented wind-catchers are pre-Ottoman. The few wind-catchers mentioned here include the earliest known examples and the earliest surviving examples and a few others which are illustrated in the literature or on the internet. I shall then discuss my favourite *bādahanj*, recently destroyed, which represented the culmination of the medieval tradition.

The Convent of St. George

> " ... Le plafond du saint des saints ... est percé d'une grille ayant appartenu à un *malqaf*. ... ... Les *malqaf*s du Deir constituent les plus anciens que l'connaisse de ce dispositif dans l'architecture égyptienne postérieure à la conquête musulmane." / " ... The ceiling of the Holy of Holies ... is pierced by a grille which would have belonged to a *malqaf*. ... The *malqaf*s of the

[324] Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971), pp. 13-15.

> Dayr are the oldest we know of this kind of device in Egyptian architecture after the Muslim conquest." A. Lézine, "Les salles nobles des palais mamelouks" (1972), p. 79.

The Convent of St. George, also known as Dayr al-Banāt, is of uncertain date but nevertheless early, still houses the *qāʿa* of a medieval palace within its western part. Peter Sheehan in his 2010 study of Old Cairo says that its high ceilings "were designed for cool summer living, with *malqaf*s (windcatchers) to draw the cool north wind down through the hall".[325] Alexandre Lézine, and after him Olivier Jaubert (#14), had already mentioned the two *malqaf*s, whose presence was attested only by the grilles in the ceilings of the two rooms below, as the oldest known ones after the Islamic conquest.[326] Alas, we do not know what these *malqaf*s looked like on the upper outside walls or on the roof, and what they were called at the time they were installed. (The term *malqaf* meaning wind-catcher is attested only from the first half of the 19th century onwards.)

The Mosque of al-Ṣāliḥ Ṭalā'iʿ

The Mosque of the Fatimid *wazīr* al-Ṣāliḥ Ṭalā'iʿ (Jaubert #17) dates from before 1154. It was originally fitted with a *bādahanj*, a feature apparently first noted in modern times by Creswell.[327] He provides the following details:

> "In the back wall, immediately behind the place where the Imam stands in the pulpit, is a rectangular opening 71 cm wide and 1.82 m high, which is surrounded by a frame of stucco ornament and closed by a bronze grille

325 Sheehan, *Babylon of Egypt – The archaeology of Old Cairo and the origins of the city* (2015), p. 108.

326 Lézine, "Les salles nobles des palais mamelouks" (1972), pp. 74 & 79, figs. 6 & 7; Maury & Revault, *Palais et maisons du Caire*, I (1975), pp. 77 & 78; and Jaubert, "Capteurs de vents" (1995), p. 188 (no. 14).

327 Creswell, *Muslim architecture of Egypt* I (1952), pp. 284-285, pls. 105d and 108d.

[here **Pl. Q4a**] and which opens into a rectangular vertical shaft, the bottom of which is flush with the bottom edge of the opening; the latter is 4.25 m above the floor. The shaft, which measures about half a metre square, continues upwards in the thickness of the wall until it reaches the level of the roof. At this point there must originally have been a sloping lid like a trap-door, closed at the sides but open towards the north, the direction of the prevailing wind, for it is quite obvious from similar structures still in use, e.g. in the Musāfirkhāna Palace (end of XVIIIth century), that this shaft served a *malqaf*, or wind-catcher, by means of which the northern breeze was driven down into the interior of the sanctuary."

With hindsight we can add that the Mosque is aligned in the *qibla* of Ibn Yūnus, as are the al-Azhar and the al-Ḥākim Mosques, a fact that nobody has ever mentioned (excepting myself and then Jonathan Bloom). Also, this device would not have been called a *malqaf* in the 12th century; the medieval name was *bādahanj*. Further, the wind-scoop would not have been facing north, but rather NNE, and the west side would have been open and the east side closed – see **Chs. 11 & 17-19**. How this was achieved we may never know, because no trace of any wind-catcher survives and the top of the shaft has been filled in during restoration work.[328]

This wind-catcher is appropriately singled out for special consideration by Robert Daniel.[329] The Wikipedia article on this particular Mosque, written by an anonymous scholar, presents all sorts of details but not unexpectedly ignores the remains of the *bādahanj*.[330]

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328 Jaubert, "Capteurs de vents" (1995), p. 189, no. 17.

329 https://en.wikipedia.org/wiki/Al-Salih_Tala%27i_Mosque.

This example is important not least because it shows that within two centuries of the founding of Cairo an important mosque was fitted with a *bādahanj*. Since the astronomical texts start mentioning the *bādahanj* about the year 1000, it is not unreasonable to suppose that most significant buildings in Fatimid Cairo were fitted with these devices. Indeed, some 200 years before the al-Ṣāliḥ Ṭalā'iʿ Mosque, there was a بادهنج المنبر, "the *bādahanj* of the *minbar*", in the al-Azhar Mosque. This was mentioned in **Ch. 4** in connection with the Fatimid ruler al-Muʿizz (*reg*. 953-975) giving the Ramadan sermon there in the year 362 Hijra (972/73).[331]

The *khānqāh* of Baybars al-Jāshankīr

This *ṣūfī* convent built in 1306-10 is one of the earliest surviving *khānqāh*s. It was built to accommodate some 400 *ṣūfī*s and children of the Mamluks. The complex has been studied in 1987 by Eleonora Fernandes, professor at the American University in Cairo, in the light of its *waqf*, history and architecture.[332] It boasted some seven *bādahanj*es, five for the madrasa and two for the mausoleum, and we have already seen two of them mentioned in an extract from the *waqfiyya*.[333]

The *Madrasa* of the Sultan al-Nāṣir Muḥammad

This early-14th-century edifice (Jaubert #22) lines the thoroughfare known as *al-Qaṣaba*, which at this point is not exactly parallel to the Canal, but some of the kinks in it seem to result from a deliberate attempt to align the buildings with the *qiblat al-ṣaḥāba*. The facade of the *Madrasa*

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331 See n. 101 above.

332 Fernandes, "The foundation of Baybars al-Jashankir: its waqf, history, and architecture" (1987), and further Jaubert, "Capteurs de vents", pp. 191-192 (#24).

333 See the text to n. 181 above.

is aligned with that direction and the interior with the *qibla* of Ibn Yūnus.[334] Thus we can see a 10° difference between the outer and inner walls, also attested in other Mamluk buildings – see **Pl. U6**. The two *miḥrāb*s **M** face the *qibla* of Ibn Yūnus and so do the three windows **W.** On the other hand, the bottom of the shaft for the wind-catcher **V** is aligned in that same direction, so one can anticipate that the wind-catcher which once capped it would have been oriented so that it was open in a direction perpendicular to the *qiblat al-ṣaḥāba*.

The *Qāʿa* of Muḥibb al-Dīn al-Shāfiʿī al-Muwaqqiʿ

The imposing pavilion on top of the *Qāʿa* (reception hall) of Muḥibb al-Dīn al-Shāfiʿī al-Muwaqqiʿ also known as the *Qāʿa* of ʿUthmān Katkhūda (Jaubert #27), dating from 1350, takes pride of place over the wind-catcher which still features on the same roof nearby. But the unsigned cross-section plan of this complex, possibly prepared by Hassan Fathy himself, showing the wind-catcher on the left, the pavilion in the middle and the splendid facade on the right – **Pl. Q1** – appears frequently in the literature. A rare photo shows most of the complex and barely catches the wind-catcher.[335] However, a unique photo of the *bādahanj* on its own is fortunately available: see **Pls. Q2-3**.[336] What is remarkable is that the device appears to be made mainly of stone or bricks, although the top cover might be made of two sets of wooden struts laid perpendicular to each other. Closer inspection would be worthwhile.

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[334] Creswell, *Muslim architecture of Egypt* II (1957), pp. 234-240, esp. fig. 137 opposite p. 238; also King, "Architecture and astronomy", p. 118 / *Synchrony*, VIIb: 809-810.

[335] Bahadori & Dehghani-sanij, *Wind Towers – Architecture, climate and sustainability* (2014), p. 94.

[336] Garcin & Maury & Revault & Zakariya, *Palais et maisons du Caire*, I: *Époque mamelouke (XIIIe-XVIe siècles)* (1982), pl. 60.

Bayt al-Suḥaymī

Even though the Bayt al-Suḥaymī (1648, 1796) (Jaubert #46 & #57) is a popular tourist destination, the cute wind-catcher on its roof – **Pl. Q5** – is still hardly a tourist attraction. Amongst the hundreds of images of the edifice accessible on the internet by googling "Bayt al-Suhaymi" there is only one image of the outside of this wind-catcher and only one image from the inside of its front screen.

Alexandre Lézine stated that there were at least five *malqaf*s on this house,[337] of which some on the second floor were in a ruinous state, and perhaps a sixth one was to be found in a *qāʿa* that was inaccessible to him. It seems that this remark of his may refer to another building.

On the egyptianmuseums.net site[338] someone has written:

> "Within Bayt Al-Suhaymi we find high ceilings which allowed the warmer air to rise and then to be swept away by the north facing *maqʿad* (wind scoops) in the upper walls which caught the prevailing breezes and circulated the cool air throughout the house."

Here even the wrong Arabic word is used for the "scoops". The term *maqʿad* is used for the sitting-area in the house below, from root *q-ʿ-d*, "to sit", whence also, for example, *al-qāʿida*, "the base".[339] Of the 16 images of the architectural jewel on that site, including one of an empty roof, there is not one of the wind-catcher. Neither in the anonymous Wikipedia article nor in Takeo Kamiya's article on "Masterpieces of Islamic architecture"

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337 Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971), p. 15.

338 www.egyptianmuseums.net/html/bayt_al-suhaymi.html

339 It is strange how few Westerners seem to know what the Arabic word *al-qāʿida* means, and, conversely, what this common English expression means in Arabic.

is there any mention of the wind-catcher.[340] In a three-minute YouTube video on the "Beat El Sehemy" by Connolly Cove there is not a single shot of the *malqaf*.[341]

The Bayt al-Suḥaymī was restored in 1996-97 under the direction of Dr. Asaad Nadim.[342] In the 40-page report there is no reference to the *malqaf*, which perhaps had been restored previously, if now with the west side closed. In any case, the photos in the richly-illustrated report indicated that there is a small domed pavilion in front of the *malqaf*, large enough to ensure that little of the available cool northerly winds could reach the *malqaf* anyway – **Pl. Q5a**.

Bayt al-Sinnārī

The house of the *amīr* Ibrāhīm ibn Katkhudā al-Sinnārī (Jaubert #56) dates from 1794. The modest wind-catcher illustrated in a 20th-century sketch with an Arabic inscription bears no relation to an image on the internet – **Pl. Q6-8**.

The Palace of al-Jawhara in the Citadel

A solitary wind-catcher (Jaubert #63) is all that appears to remain of the ventilation system of the Palace, which edifice, along with the Citadel, has been studied by Nasser Rabbat.[343] The wind-catcher is dated by Jaubert to the period 1814-1829. It has been improperly renovated, both sides being

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340 https://en.wikipedia.org/wiki/Bayt_Al-Suhaymi and www.ne.jp/asahi/arc/i—*—nd/2_meisaku/26_suhaymi/suh_eng.htm.

341 https://www.youtube.com/watch?v=46bNZXhtN7k.

342 Nadim / Suhaymi: *Bayt El Suhaymi – Documentation, Restoration & Conservation Project, 1996-1997*, Cairo, (1997), pp. 36, 8, 9, 33.

343 Jaubert, "Capteurs de vents" (1995), p. 206 (#63) and figs. 15 & 16 on p. 226. See also Rabbat, *The Citadel of Cairo* (1989).

closed – **Pl. Q11**.

The S*abīl-kuttāb* of Aḥmad Bāshā

The wind-catcher in the *sabīl-kuttāb* of Aḥmad Bāshā dates from 1864 (Jaubert #67). A partial image of the front of the top was the sole photo included by Olivier Jaubert in his 1995 study – **Pl. Q12**.[344]

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The above remarks about a handful of *bādahanj*es are woefully inadequate. They were written amid the hilltops of rural France rather than on the rooftops of Cairo. The reader must turn to Jaubert 1995 for more information on many more examples, mainly recorded after direct personal inspection.

The spectacular *bādahanj* on the former Musāfirkhāne Palace

> "Il est dit dans un passage du §4 du 217° rapport relatif à la Moussaferkhâna que l'Administration générale des Waḳfs demande un état des boiseries demandées par le Comité, indiquant leux prix et le chef auquel le montant de ce compte doit être imputé. Comme **ces boiseries n'ont rien de particulier**, leur genre étant bien représenté au Musée arabe et que d'autre part il faut les acheter, le Section technique propose de s'en désinteresser, à moins qu'on ne les cède gratuitement au Comité." / "It is stated in §4 of the 217th report in a passage relating to the Musāfirkhāne that the general administration of Waqfs requests an inventory of the decorated woodwork requested by the Comité, indicating their price and specifying the official to whom the amount should be charged. Since **this decorated woodwork is nothing special**, their kind being well represented at the Arab Museum and because they

344 Jaubert, "Capteurs de vents" (1995), p. 220, fig. 1.

would have to be purchased, the Techical Section (of the Comité) proposes to withdraw its interest, unless they are given to the Comité for free." *Bulletin du Comité de Conservation des Monuments de l'Art Arabe*, 1899, p. 106.

"The birthplace of Khedive Isma'il, the building was devastated by a fire in October 1998 that destroyed all of its outstanding mashrabiya windows and wooden ceilings. Prior to this event, the palace had been extensively restored by the Comité, which was initially reluctant to register it owing it its dilapidated condition. Additional features of interest in the building were its large malqaf and elaborate hammam." Nicholas Warner, *The Monuments of Historic Cairo* (2004), p. 90 *ad* no. 20.

The enormous and imposing wind-catcher on the roof of the late-18th-century Musāfirkhāne Palace was until 1998 one of the very few surviving examples of a real medieval-type *bādahanj*, and it was by far the most impressive. Of course, it was not "medieval", but it was very much in a medieval tradition, and although it was erected during the Ottoman period, it was not an Ottoman invention and it was not imported from anywhere. In addition, it showed every sign of having been erected according to the detailed instructions presented in centuries-earlier astronomical texts.

We know that centuries earlier, in Fatimid times, *bādahanj*es of this size and even larger adorned the roofs of Cairo palaces. Obviously, they were unnecessary on normal houses.

I find it strange that no Egyptian scholar in the 18th and 19th centuries appears to have written about this splendid edifice. It seems to have first attracted serious scholarly attention from the Sicilian architect, historian and prolific writer Achille Patricolo (b. 1877) in the 1922 issue of the *Bulletin du Comité de conservation des monuments de l'art arabe*,[345] and thereafter only from a series of French historians of Cairene architecture

[345] On Patricolo and his contributions see Pallini, "The revival of Islamic architecture in Egypt: the Italian contribution" (2005), p. 3.

in the series *Palais et maisons du Caire* between 1970 and 1995.[346] Of course, it gets special mention by Olivier Jaubert.[347]

During my Cairo days (1972-79), I was much impressed by this splendid construction, and later illustrated my 1984 study with photos of it from the year 1979. For these and other photos see **Pls. R1-3**. There is no need for me to describe the *bādahanj* here; the photos speak for themselves.

The destruction of the Musāfirkhāne Palace

> "You have a *bādahanj* like a sad (mourner) which has
> A breath that has become laboured and painfully short.
> The zephyr has died in it, and all of us
> Cry and mourn for it with tears of sweat."
> The Egyptian poet Abu 'l-Fatḥ Ibn Qādūs (d. 1156)

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[346] Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971), pp. 13-14 and notes.

Fortunately, the palace named al-Musāfirkhāne (constructed 1779-1788) is described in detail in Patricolo, "Service de conservation des monuments : exposée des travaux executés ... " (1922), pp. 187-190, and pls. CCXXIV-CCXXX; the I.F.A.O. publication *Palais et maisons du Caire* (III: 14th-18th C), 1979, pp. 147, 148, 150, fig. 38, & pls. XCIV-A & XIV-A; and the C.N.R.S. publication *Palais et maisons du Caire* (II: 16th-18th C), 1983, pp. 230 & 234, pl. LVI-LVII, fig. 100.

In the most recent survey of Cairene historical architecture – Warner, *The Monuments of Historic Cairo* (2004), p. 90 (no. 20) – the Musāfirkhāne *bādahanj* and the fate of the palace is mentioned.

(Alas for the wind-tower on the Cairo Musāfirkhāne on the internet, there is a town in Uttar Pradesh named Musāfirkhāna and an Urdu song containing the words *musāfir* and *khāne* which inevitably dominate the relevant Google pages.)

[347] Then we have Jaubert, "Capteurs de vents" (1995), pp. 202-203 (#54), who comments on the "immense" size and compares it with those on the Palaces of Alfī Beg and Ḥasan Kāshif illustrated in the *Description de l'Égypte*. He does not comment on the fact that the western side is open, whereas the eastern side is closed.

> “What is the interest of the setting, now that the precious stone is gone?” French architect and specialist on historical Cairene architecture, Bernard Maury, adviser on restoration to the Egyptian Ministry of Culture, on the occasion of the fire which destroyed the Musāfirkhāne Palace in 1998, quoted in Fayza Hassan, “Sinning by omission” (1998).

In October 1998 the Musāfirkhāne Palace burned to the ground. Apparently it was a disaster waiting to happen.

The various reports in the Egyptian press bemoaned the loss of this architectural pearl of a palace with barely a mention of the wind-catcher.[348] Nobody realized how important the splendid wind-catcher was: a symbol of a City Victorious for close to a millennium. Nobody in Cairo would have known that this was the sole surviving monumental wind-catcher in Cairo that was built according to the prescriptions of medieval architects (and astronomers!). I am not convinced that many people cared anyway, apart from the tourists who visited the ruins and cried because the Palace was gone – **Pl. R4**.

A thoughtful video was compiled by an outfit called elmwatin.com (= المواطن, al-Muwāṭin, “The Citizen”). The commentator addressed the subject “المسافرخانه من الجمال الى الاهمال”, *al-Musāfirkhāne mina ‘l-jamāl ila ‘l-ihmāl*, which translates as “The Musāfirkhāne, from beauty to neglect”, where the Arabic words for ‘beauty’ (*jamāl*) and ‘neglect’ (*ihmāl*) rhyme. In addition to a few scenes before the fire, the video showed the piles of trash accumulated in the Palace, and numerous scenes of devastation after the fire.[349] Of course, the wind-catcher was not mentioned.

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348 Fayza Hassan, “Sinning by omission” in *Al-Ahram Weekly On-line* (Nov., 1998), and Sara Nur, “The Musafirkhane in pictures ... The most beautiful historical palace in Cairo (reduced to a scene of) devastation” (2018).

349 Anonymous, “المواطن – المسافرخانه من الجمال الى الاهمال”// “The Citizen (al-Muwāṭin): The Musāfirkhāne, from beauty to neglect”, at www.youtube.c—*—om/watch?v=DSsESQ41VmY.

A scholarly article published in 2010 by the Oxford-based Egyptian architect Mohamad Kashef, who obviously did care, discussed the layout and decoration of the Palace and its place in historical Islamic domestic architecture. Yet even this otherwise praiseworthy article contains neither any specific mention of the enormous wind-catcher that used to grace the edifice nor any photos thereof such as were already available on the internet.[350]

In 2107 Hossam Mahdy, an Egyptian independent researcher and freelance consultant on the conservation of cultural heritage (who is not

[350] Kashef, "Musafirkhana Palace: the lost architectural treasure" (2010). The author's general remarks on *malqaf*s are without any references.

very fond of orientalists[351]), wrote in his book on the conservation of historical Cairo the following about the disaster (my emphasis):[352]

> "In October 1998, a fire destroyed the al-Musafirkhana Palace in the historic al-Gamaliyah district of Cairo. The Palace was highly significant because of its architectural, aesthetic and historic values. The birthplace of Khedive Isma'il, **it was an Ottoman palace known for its very beautiful courtyard, lattice-wood windows (*mashrabiya*), wind-catchers and private hammam.** In the late 1980s, the palace had been shored up and considered for structural restoration works. It had been closed to the public for almost ten years, during which no restoration work was ever started. It gradually became a garbage dump for the surrounding residential

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351 Nowadays it seems to be *de rigeur* in some circles to point out how bad orientalists are. Thus Hussam Mahdy, writing in 2017 on the conservation of Cairo, summarizes:

> "Such arrogance and lack of sensitivity are not unusual to observe when consulting Orientalists' interpretations of Arab and Muslim issues. Thus, it is not difficult to understand how Orientalists dared to feel free to interpret, alter and ridicule the values of Islamic-Arabic ideology and culture. A 'hypothesis' by an Orientalist is often taken by another as a sound 'theory', and by a third as a 'fact'; it then appears and reappears in almost all writings on the same subject as 'stating the obvious'. This explains why most Islamic-Arabic texts written since the early years of the 20th century assure the reader that their ideas and information are based on Islamic and not Orientalists' sources."

Mahdy does not say which orientalists he has been reading. Until a few year ago I was not aware of a single orientalist who deliberately "altered" or "ridiculed" any aspect of the history of Islamic civilization, but now with the revisionists no hold are barred. And amongst orientalists I was thinking about serious scholars, certainly not authors of non-serious "popular" literature, reporters, media, internet.

For the above quote see Mahdy, *Approaches to the conservation of Cairo* (2017), pp. 51-52, esp. p. 52. This is partly based on the author's 1992 PhD dissertation. Mahdy is also the author of an *Arabic Glossary for the terms of conservation for cultural heritage, with English equivalents*, available at /www.academia.edu/34527198/, which does not feature technical terms such as *malqaf*, let alone *bādahanj*.

352 Mahdy, *op. cit.*, p. 73.

> buildings. When the building caught fire, there were no fire-extinguishers on site; the fire engines that eventually arrived were too big to enter the narrow alleyways to reach the palace. After the fire had destroyed al-Musafirkhana, anger was expressed publicly in cultural circles and in the media, since it was obvious that the nation had [lost] this precious heritage due to misconduct by the SCA [Supreme Council of Antiquities] and the Minister of Culture. Dr. Gaballah, the SCA Secretary General at the time, was fully apologetic and accepted responsibility. "If it was decided to hang me in a public square for the loss of al-Musafirkhana, I would accept". The Minister of Culture, however, denied his Ministry's responsibility for the loss and said that he would "allocate 30 million Egyptian pounds to reconstruct a new al-Musafirkhana that would be as good as the lost one!".[5]

The importance of the wind-catcher of the original Musāfirkhāne has simply been overlooked in the last few decades. It is not stressed in the above quote, in which "wind-catchers" in the plural are mentioned: there was only one! The only images of it now on the internet are those taken by myself in the 1970s, by the Institut Français d'Archéologie orientale around 1980, and by Nasser Rabbat in 1985 (on ArchNet.org). Already during the 1970s I heard from several colleagues in architectural history that this magnificent structure is "not important" because it is so "late", reflecting first, a general antipathy in Egypt toward anything that is not Ancient Egyptian and specifically in Cairo toward anything Ottoman or indeed toward anything pre-Ottoman, and second, an ignorance of the fact that such enormous wind-catchers are attested since Fatimid times. Since then, the history of Ottoman architecture has become a discipline in its own right, inevitably weak on interpreting orientations, but now the most significant Ottoman-era wind-catcher in Cairo is no more. This fortunately does not change the fact that the history of the wind-catchers of Cairo spans the Fatimid, Ayyubid, Mamluk and Ottoman periods, and is perhaps even related to the Ancient Egyptian tradition. This latter putative association might be the only way to attract any attention to this singular, distinctive and sensible tradition. Few will want to hear that the idea of the Egyptian *bādahanj* actually goes back to Iran.

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All this and more is just part of a general disregard in Egypt for the Islamic heritage which is not considered worth showing to tourists, who much prefer pyramids, temples and beaches anyway. Every now and again a voice can be heard reminding us that Cairo's Islamic heritage is actually worth saving.

A good place to start is István Ormos, "Preservation and Restoration – The methods of Max Herz Pasha, Chief Architect of the Comité de Conservation des Monuments de l'Art Arabe, 1890-1914" (2002), appropriately published in the *Festschrift* for George Scanlon, and the same author's "The Comité de Conservation des Monuments de l'Art Arabe: Towards a Balanced Appraisal" (2019).

There is plenty of material for further reading. See, for example, Paul Bergne, "Cairo: can the medieval city be saved?" (1978); Michael Meinecke, ed., "Islamic Cairo: Architectural conservation and urban development of the historic center" (1980), containing over a dozen contributions by leading scholars of historical Cairene architecture; Jim Antoniou *et al*., *The Conservation of the Old City of Cairo* (1985), a report prepared for U.N.E.S.C.O.; Caroline Williams, "Islamic Cairo: Endangered Legacy" (1985) & "Transforming the Old: Cairo's New Medieval City" (2005); various articles in Jere Bacharach, ed., *The Restoration and Conservation of Islamic Monuments in Cairo* (1995); Giuseppe Fanfoni, "The preservation of historic Cairo" (2001), dealing with three specific examples; various articles in Wolfgang Mayer & Philipp Speiser, eds., *A future for the past – Restorations in Islamic Cairo, 1973-2004* (2007); Hussam Mahdy, *Approaches to the conservation of Cairo* (2017); Karen Dabrowska, "Egyptian architect battles to preserve Cairo's heritage" (2018), on the "Save Cairo" project of Omniya Abdel Barr; also the anonymous articles "Is historic Cairo doomed to disappear?" (2013), and "Egypt struggles to restore historic Cairo's glory" (2018). Other parts of historical Cairo are being demolished as I write these words, despite being "part of the UNESCO heritage site of Islamic Cairo" and despite "signifying a nation's collective memory and architectural mosaic" – see Pariesa Young, "Graves in Egypt relocated and demolished to make space for a highway" (2020).

9 — The Cairo wind-catchers recorded by Olivier Jaubert

These are the Fatimid, Ayyubid, Mamluk and Ottoman edifices with wind-catchers in the ground-breaking catalogue of Olivier Jaubert, who wisely treats them chronologically.

The reader should keep in mind that, given the wealth of such monuments that were once to be found in medieval Cairo, these listed so conscientiously and meticulously by Olivier Jaubert below are like the left-overs from a sumptuous meal, poor pickings indeed from a city in which *bādahanj*es were once to be found on most buildings.

Jaubert gives considerable information on the way in which the surviving *bādahanj*es function, and the way in which they enable the air to circulate in the rooms of the houses they dominate. No such details are given in the present study.

I refrain from giving any more details in order that readers may be encouraged to consult Jaubert's study for themselves. I do, however, wish to stress that the references are not only to domestic architecture but also to mosques, madrasas and other buildings serving a socio-religious function. Items in bold have been discussed elsewhere in this monograph.

1-9 Ancient Egyptian buildings

10-11 Christian buildings

12 Muslim cemetery at Touna el-Jebel

13 House 6, Fustat

14 **Dayr al-Banāt, 11th C**

15 *Qāʿa* of Aḥmad Bey Kuhyam, 11th & 14th C

16 Mosque of Najm al-Dīn al-Lamaṭī, Minya, 1154

17 **Mosque of al-Ṣāliḥ Ṭalā'iʿ, 1160**

18 House at Fusṭāṭ, 1190

19 *Qāʿa* of al-Dardīr, 12th C

20 al-Kāmiliyya Madrasa, 1129

21 **Mausoleum of Sultan Qalāwūn, 1284-85**

22 Madrasa of Sultan al-Nāṣir Muḥammad ibn Qalāwūn, 1295-1304

23 Madrasa of the *amīr*s Sanjar and Salār al-Jawlī, 1303-1304

24 *Khānqāh* and mausoleum of Baybars al-Jāshankir, 1306-1310

25 Palace of the *amīr* Bashtāk, 1334-1339

26 *Qāʿa* of al-Irsān or *Qāʿa* of al-Rayyis, 14th C

27 ***Qāʿa* of Muḥibb al-Dīn al-Muwaqqiʿ or *Qāʿa of* ʿUthmān Katkhudā, 1350**

28 *Khānqāh* of the *amīr* Shaykhū, 1355

29 *Qāʿa* of Sayf al-Dīn Tashtamur or Mosque of Khushqadam al-Aḥmadī, 1366

30 Mosque of Qānibāy al-Muḥammadī, 1413

31 Mosque of the *amīr* Qarāquja al-Ḥasanī, 1441-1442

32 House of Zaynab Hātūn, 1468

33 Palace of the *amīr* Jānim, document dated 1479

34 Palace of Sultan Qā'it Bāy, 1483

35 Palace of Shihāb al-Dīn, document dated 1484

36 Palace of Aḥmad Katkhudā al-Razzāz, 15th C

37 *Maqʿad* of the Palace of the *amīr* Mamāʿī, 1496

38 Mosque of Murād Bāshā, 1578

39 House Waqf al-Ḥaramayn, 16th C

40 House of al-Sādāt al-Wafā'iyya, 15th C ...

41 House no. 6 in Ḥammām Bashtak street, 16th or 17th C

42 House of Muṣṭafā Shalabī Sinān, 17th C

43 House of Jamāl al-Dīn al-Dhahabī, 1634

44 House of Maḥmūd al-Shabshīrī, 17th C

45 House of al-Sitt Wasīla, 1637

46 **House of al-Suḥaymī, 1648**, 1796 (see #57)

47 Palace of the *amīr* Riḍwān Bey, 1650

48 Mosque of Muṣṭafā Shūrbajī Mirzā, 1698

49 House of Harāwī, *ca*. 1731

50 Mosque of the *amīr* ʿUthmān Katkhudā, 1734

51 House of al-Sādāt al-Wafā'iyya, 16th C, ...

52 The Church al-Muʿallaqa, restored 1775

53 Palace of Aḥmad Katkhudā al-Razzāz, 15th C, 1778

54 **Palace called Musāfirkhāne, 1779-1788**

55 Mosque of Maḥmūd Muḥarram, 1792

56 House of the *amīr* Ibrāhīm Katkhudā al-Sinnārī, 1794

57 **House of al-Suḥaymī, 1648, 1796 (see #46)**

58 **Mosque of Najm al-Dīn al-Lamaṭī, Minya, print, 1798-1801**

59 **House of Alfī Bey, print, 1798-1801**

60 **House of Ḥasan Kāshef – "L'Institut", print, 1798-1801**

61 **Houses in Bulaq, print, 1798-1801**

62 **Houses in Al-Ezbekiyya, print, 1798-1801**

63 **Palace of al-Jawhara, 1814-1829**

64 *Qaṣr* (castle) of al-Ḥarim, 1827-1843

65 Mosque and *sabīl* of Sulaymān Aghā al-Silaḥdār, 1839

66 *Wakāla* and *sabīl-kuttāb* of the Waqf al-Ḥaramayn, 1856

67 ***Sabīl-kuttāb* and *funduq* of Aḥmad Bāshā, 1864**

68 Sabīl of Umm ʿAbbās in Salība street, 1867

69 **Mosque of al-Azhar, 970-972, print, 1878**

70 Foundry for cannons, Bāb al-ʿAzab, Citadel, 19th C

71 **Work-shops, Bāb al-ʿAzab, Citadel**

72 Two streets near the al-Ghūrī Mosque, 19th C

73 *Wakāla*, 19th C

74 *Wakāla*, 19th C

75 Mosque of Shaykh Ṣāliḥ Abū Ḥadīd, 19th C

76 Bayt al-Muftī, 1870

77 Mosque, Minya, 19th C

78 City of the Dead, Bāb al-Wazīr, Qā'it Bāy and S. necropolis

79 City of the Dead, Bāb al-Naṣr, 19th-20th C

80 Covered street, al-Fayyūm

81-85 Modern examples

The Cairo wind-catchers hit the press, if only three of them

A brief notice in Arabic on the website of the Cairo-based Devian TV on 12.09.2018 announces "Air-condition[ing] for Nothing (تكييف ببلاش, *takyīf bi-balāsh*)".[353] The author, Hazem Nour, points out that *malqaf*s could keep the temperature inside at 25° when the temperature outside was 45° (really?) and ventures to explain how this was achieved. He notes the locations of three *malqaf*s in Cairo supposedly in their original state: the

[353] Hazem Nour, حازم نور, "تكييف ببلاش, Air conditioning for nothing" (in Arabic) (2018).

ajwaMosque of al-Ṣāliḥ Ṭalā'iʿ, supposedly in its original state (*sic*); the Kāmiliyya Madrasa; and the Khānqāh of Baybars al-Jāshankir. Unless I am mistaken, this information stems originally from the study of Olivier Jaubert (#17, #20, #24).

A new contribution by Lamees al-Dasouqi

The reader may imagine my surprise, and pleasure, in mid-June, 2019, at learning of a 2014 Master's thesis in Arabic from Ayn Shams University submitted by an Egyptian student, Lamees al-Dasouqi / Lamis El Dessouki (لميس الدسوقي), and dealing with the Cairo wind-catchers from a historical perspective.[354] I have not seen this work, but not for lack of trying. An English summary is available on the internet and I include it below. It seems to rely heavily on Jaubert's 1995 study, which is a very good thing, and appears to be innocent of the studies of Rosenthal 1987 and King 1984, which is a pity. Particularly promising is the inclusion of 107 diagrams and 137 photographs. I look forward to seeing these in the not-too-distant future. Here is the summary (unmodified, my emphases in bold):

> "The Wind catchers (Mlaaqaf al-Hawa'). Egyptian solution architecturally to the problem of temperatures rising up in urban and desert climate, which lies on the outskirts of some cities, hence the importance of this topic in the field of Islamic architecture through the ages, starting from Tulunid to the end of the Ottoman era through Fatimid and Ayyubid [then] Mamluk eras.
>
> This subject has never been under scientific study by specialists, but used to be (mentioned) partially in studies, some in the field of Islamic Archaeology and some of them in engineering such as the master Thesis,

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[354] al-Dasouqi, *The Wind Catchers in the City of Cairo in the Mamluk and Ottoman periods (1250-1914)*, Master's thesis in Islamic Archaeology, Ayn Shams University, 2014: see http://srv4.eulc.edu.eg/eulc_v5/Libraries/Thesis/BrowseT—*—hesisPages.aspx?fn=PublicDrawThesis&BibID=12103496.

Faculty of Engineering, Minia University of **Khaled Selim Vajal** titled "Developing Malqaf al-Hawa' in order to be used in contemporary Egyptian architecture", but did not refer to Mlaaqaf effects of the Mamluk and Ottoman eras, and Photographed, but noted Malqaf qaa Muhibb al-Din, Malqaf Palace Gawhara, and photographed, and an article by the French scholar **Olivier Jaubert** entitled (Capteurs de vents d'Égypte), which describes Mlaaqaf al-Hawa' in Egypt but **incomplete**, and Ph.D. thesis of **Imad Ajwa**, Faculty of Archeology entitled architectural solutions treatment of the phenomena of climate architecture Cairo since its inception until the end of the Ottoman era, includes an overview of the Mlaaqaf during the Pharaonic era, and different Islamic eras, included photographs mostly.

Perhaps the regularity of the climate atmosphere in Egypt and the stability of North wind directions explains the prevalence and persistence of these Almlaagaf be simplified. And shape Egyptian Mlaagaf back to the Pharaonic era, however, is still a distinct and cone44tinuing until the end of the Ottoman era, and often were made of pure wood, and draws their openings towards the northeast or northwest, as well as towards the south and east towards the southwest [*sic*].

This thesis consists of an introduction and preface, four chapters and a conclusion and List of sources and references. The following is a summary of the contents of these chapters:

Chapter I: Its address of the factors affecting the wind catchers (al Mlaaqaf) in Islamic architecture, and includes a definition of the Wind catcher (al-Malqaf), factors affecting climate in Cairo, technical description of the wind catchers (Mlaaqaf al-Hawa'), building material [of] the wind catchers (al Mlaaqaf), and roofing the wind catchers (Mlaaqaf al-Hawa').

Chapter II: Its title The Wind catchers (Mlaaqaf al-Hawa') sources and documents in the Mamluk and Ottoman [eras], deals with the names The Wind catcher (Malqaf al-Hawa') in the Mamluk and Ottoman eras and places that we found out specifically, this Wind catchers (al-Mlaaqaf) material industry.

Chapter III: Its title The Wind catcher (Malqaf al-Hawa') during the Mamluk period, and includes an overview of the Mlaaqaf with a detailed

explanation to them, and their places in the installations, with giving brief summary of these facilities by dividing the chapter to: First: religious facilities included (mosques, schools and Khanquaoat [!]), Secondly: civilian facilities included (palaces and houses). Also addresses the relationship Almlaaqaf elements of lighting and ventilation installations inside. The bottom line is that this chapter stressed that Almlaagaf various types found in most installations, despite their diversity between religious and civil.

Chapter IV is entitled The Wind catcher (Malqaf al-Hawa') during the Ottoman era and includes an overview of the Mlaaqaf with a detailed explanation to them, and their places in the installations, which increased diversity during this era, with a brief explanation of these facilities by dividing the chapter to: First: religious facilities of Ottomans, secondly: religious facilities of the era of the family of Muhammad Ali Pasha, Third: Ottoman civilian facilities, fourth: civic installations of the family of Muhammad Ali. Fifth: commercial establishments of the era of the family of Muhammad Ali Pasha, I was keen to clarify the interaction with the elements of al-mlaaqaf lighting and ventilation inside the installations, and proved this chapter al-mlaaqaf frequent use of the wooden ceiling italics beside other types of Mlaaqaf. It also provided the study by 107 diagrams, and special album contains 137 photographic plate.

Finally, a conclusion included a presentation of the most important results of the search, and most important: different angle of inclination of this type of al mlaaqaf during the Mamluk and Ottoman eras, and that the best angle of inclination to grab the air is 30 ° degrees [?], and the use of architecture al mlaqaf as an optimal solution to the problem of damage detection, it which is forbidden by Islam and Vgahaúh [??], and the clear relationship between planning and al-mlaaqaf, where any able architect in the Mamluk and Ottoman eras take into account design rules for linking Almlaagaf and surmounted by a space, and devoid of decoration al mlaaqaf Mamluk, while less appearance on al-mlaaqaf during the Ottoman era. And so many of the results have been reached. As well as three schedules: First Schedule includes limitation types Almlaagaf which been received the study, and the second Schedule includes the degree of inclination Mlaagaf Second type ever italicized ceiling, which been received the study, and the Third schedule includes misaligned Almlaagaf which been received the study.

> The bibliography appended to the forms and the list of the plates, which was adopted by this study, as well as the proven sources and references in Arabic and foreign languages, which was adopted by this study."

I regret very much to not have seen this work. However, we can obviously no longer claim that the wind-catchers are completely forgotten in Egypt, as some might have thought. But the wind-catchers should not remain in an unpublished Master's thesis in Arabic. There will surely be numerous places where al-Dasouqi's thesis and the present study overlap, but that will be for future investigators to determine.

Rawan Ahmed Adil

The 2015 Master's thesis in Arabic by Rawan Ahmed Adil Ali on natural illumination in Mamluk mosques and madrasas contains a short section on *malqaf*s with several informative photos taken by the author that are not available elsewhere.[355] The images taken inside the vertical shafts of *bādahanj*es are of particular historical interest. The author cites Lamis Azmi rather than Lamis al-Dasouqi as the author of the 2014 dissertation. Again, interest in the *bādahanj*es of medieval Cairo does seem to be on the rise. But Adil's thesis refers to Jaubert's fundamental study only once, quoting him as having written that the *bādahanj*es face north (يعني).

355 Rawan Ahmed Adil Ali, *Elements of architectural illumination* (2015, in Arabic), esp. 55-69. I thank Prof. Yehia Wazeri for kindly sending me an extract from this thesis in August, 2019.

(10 — Excursus: The Cairo wind-catchers in modern literature)

> “ ... the *malqaf*, the wind scoop, ... was **a standard feature of Cairene architecture**, but few survive now.” Caroline Williams, *Practical guide to the Islamic monuments of Cairo* (2008 edn.), p. 188 (my emphasis). Precisely!

Before the triumvirate – Rosenthal, King & Jaubert – the following scholars had realized that the wind-catchers of Cairo were of some importance or were at least worthy of a mention. We also identify others, mainly historians of Islamic architecture, from more recent times. We do not refer to the dozens of environmental engineers and designers, mainly Egyptian and Iranian, who have mentioned the Cairo wind-catchers in a sentence or two without any knowledge of their importance in historical Cairo. Their works are listed in the bibliography.

We cite these references not to criticize our colleagues in the history of Islamic architecture, for it is a fact that there are virtually no wind-catchers left on the monumental architecture of Cairo, and it is this religious architecture – mosques, madrasas and mausolea – that has been their main concern. After restorations of some of these *ca*. 1900 there were indeed very few wind-catchers to be seen. The French historians of Cairene architecture have concentrated on palaces and substantial houses – and they have had more access to wind-catchers and traces thereof. So it is not at all surprising that it was a French scholar, Olivier Jaubert, who was the first to document the limited remains of the once ubiquitous wind-catchers of medieval Cairo.

Rather, we cite these references to encourage all colleagues to take the history of this aspect of historical Cairene architecture seriously.

Alexander Badawy

In a ground-breaking article published in 1956, the Egyptian Egyptologist Alexander Badawy (1913-1986) published a survey of traditional Ancient

Near Eastern cooling techniques, concentrating on Ancient Egypt, Iraq and Iran.[356] The situation in medieval Egypt (and al-ʿIrāq) is referred to only in passing, and for the former Badawy's only reference is Creswell. Badawy wrote:

> "Wooden ventilators called *malqaf* (lit., "catcher") are erected above the ceilings in the shape of a prismatic tunnel, slanting to the interior and identical with [?] those appearing on the houses of the New Kingdom."

Alexandre Lézine

Alexandre Lézine (1906-1972) may be credited with bringing the subject of ventilation in Islamic architecture to the attention of the scholarly world. In his ground-breaking 1971 study "La protection contre la chaleur dans l'architecture musulmane d'Égypte" / "Protection against heat in the Islamic architecture of Egypt",[357] he offered an overview of the situation in the entire Muslim world, then concentrated on Cairo. He presented general remarks about the *malqaf*s of Cairo, and cited the text of ʿAbd al-Laṭīf al-Baghdādī, who stated *ca*. 1200 that few houses in Cairo were not fitted with *malqaf*s ("peu de maisons de la capitale en étaient dépourvues"), although al-Baghdādī actually called them *bādhanj*es.

It is of interest to note that Lézine claimed that the wind-catchers, or perhaps just the surviving air-shafts, that he had investigated faced north, north-east, north-west, east, and even south-east and south. From this he reasonably, but wrongly, concluded:

> "Il n'y a pas de règle pour la place du *malqaf*" / "There is no rule for orienting the *malqaf*."

On the other hand, Lézine is the only author ever to have noticed that:

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356 Badawy, "Architectural provision against heat in the Orient" (1958), esp. p. 125.

357 Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971). See the text to n. 29 above.

> “Le *malqaf* a son ouverture principale vers le nord et parfois une ouverture latérale supplémentaire vers l’ouest,” / “The *malqaf* has its principal opening toward the north and sometimes has a supplementary opening on the side toward the west,”

pointing to the example of the Musāfirkhāne. This is precisely what is proposed in the medieval astronomical texts, the purpose being to collect winds from the north west as well as the north-east winds embraced by the front opening.

Lézine lists a dozen other examples that came to his attention in 1970 and ’71 in the course of the preparation of his publication on Cairene palaces. It is unfortunate for studies of medieval Egyptian architecture that his study was published in Damascus, not in Cairo.

It is perhaps worth noting that about the same time that Lézine was documenting palaces in Cairo with wind-catchers, I was pondering over manuscript copies of an enigmatic table for orienting wind-catchers. Neither of us had any idea about the activities of the other. Alas, Lézine died suddenly in 1972.

I repeat an earlier remark that Lézine’s study should be the starting-point for any regional study of cooling procedures.

K. A. C. Creswell

K. A. C. Creswell identified six wind-catchers or *malqaf*s, as he called them, in his *Muslim Architecture of Egypt* (1952-59).

He provided the first serious description of at least the lower part of a *bādahanj*. Given the paucity of what was visible to him in, say, the Mosque of al-Ṣāliḥ Ṭalā’iʿ from 1160 (Jaubert #17),[358] his account of the *bādahanj* there is most insightful:

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358 Creswell, *Muslim architecture of Egypt*, I (1952), pp. 284-285, and pl. 105d.

“The *malqaf*. In the back wall, immediately behind the place where the *Imām* stands in the pulpit, is a rectangular opening 71 cm. wide and 1.82 m. high, which is surrounded by a frame of stucco ornament and closed by a bronze grille [here **Pl. Q4**] and which opens into a rectangular vertical shaft, the bottom of which is flush with the bottom edge of the opening; the latter is 4.25 m. above the door. The shaft, which measures about half a metre square, continues upwards in the thickness of the wall until it reaches the level of the roof.* At this point there must originally have been a sloping lid like a trap-door, closed at the sides but open towards the north, the direction of the prevailing wind, for it is quite obvious on similar structures still in use, e.g. in the *Musāfirkhāna* Palace (end of XVIIIth century), that this shaft served a *malqaf*, or wind-catcher, by means of which the northern breeze was driven down into the interior of the sanctuary. This is the earliest example in Cairo;** similar shafts exist in the north-western *līwān*s of the Kāmilīya Madrasa, 622 H (1225), the Madrasa of an-Nāṣir Muḥammad, finished in 703 H (1303/4), and the Khānqāh of Baybars al-Gāshankīr, 706-9 H (1306-10). In old photographs of Cairo taken from the Citadel, hundreds of such *malqaf*s can be seen.*** In ʿIrāq these devices are called *bājir*.”

* Footnote: The stone slabs with which the roof is paved have been carried across it during the restoration. ** Reference to early Syrian example - see below. *** Footnote: Reference to Frith, *Egypt, Sinai, and Palestine*, first plate, and his *Egypt, Sinai, and Jerusalem*, 11th and 13th plates.

Creswell had this to say about the air-shaft he found in the Madrasa of al-Nāṣir Muḥammad (1295-1304) (Jaubert #22):[359]

“At the back of the north-west *līwān* is a recess 1.72 m. deep, running the whole height, which when I first saw it was open at the top. I believe it to have been an air-shaft (*malqaf*), as in the Kāmiliyya Madrasa. It has since then been erroneously roofed over by the Comité together with the whole *līwān*, whereas it ought to have been given a wind hood.”

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[359] Creswell, *Muslim architecture of Egypt*, II (1959), p. 235.

Here we see his frustration at even the Comité de Conservation des Monuments de l'Art Arabe (Commission for Conservation of Monuments of Arab Art) restoring historical buildings inappropriately.

Les palais et maisons

The French scholars at the Institut Français d'Archéologie orientale in Cairo recorded all the wind-catchers they found in their documentation of Cairene palaces and houses. Their work surely provided some of the inspiration for Olivier Jaubert and information on individual examples.

J. Michael Rogers

Michael Rogers is a British orientalist with exceptional linguistic skills who is a leading specialist on the history of Islamic art and architecture. His truly monumental 1974 article "al-Ḳāhira" on the medieval City Victorious in the *Encyclopedia of Islam*, 2nd edn., concentrates on the architecture and its inscriptions over different periods, provides a map of historical buildings, is well illustrated and exhaustively documented.[360] In brief, it leaves few stones unturned. Michael mentions the wind-catchers under the rubric 'domestic architecture' when writing about Mamluk buildings:

> "Ventilation was assured by wind-funnels or towers (*malqaf*, pl. *malāqif*), facing north to catch the evening breeze, and these also occur in some religious buildings (the mosque of al-Ṣāliḥ Ṭalā'iʿ, 1160, where the shaft inconveniently issues at the top of the *minbar*, and in the *khānqāh* of Baybars al-Jāshenkir, 1306-09)."

Michael gives no indication that the wind-catchers, which were not called *malqaf* in their day but *bādahanj*, were omnipresent in medieval Cairo, as testified by ʿAbd al-Laṭīf al-Baghdādī, who stated *ca*. 1200 that there was barely a house in Cairo without one. Also, it seems to have been a custom

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360 Rogers, article "al-Ḳāhira" in *Enc. Islam*, 2nd edn., esp. IV, col. 434b.

to put *bādahanj*es in mosques in places where the *imām* or the preacher (*wāʿiẓ*) might appreciate it, unless, of course, he developed lumbago. Placing the wind-vent near the pulpit or *minbar* was intentional.

Hassan Fathy

The renowned Egyptian architect Hassan Fathy (1900-1989) could alas not have been fully aware of the diffusion of wind-catchers in medieval Cairo, although, of course, he fully exploited various other historical forms of ventilation in his futuristic traditional architecture.[361] Fathy in his much-acclaimed 1986 book on vernacular architecture in hot, arid climates inevitably discussed the *malgaf*, as he occasionally called it. The historical part of his very brief discussion is restricted to the wind-catcher on the mid-14th-century residential hall (*qāʿa*) of Muḥibb al-Dīn al-Muwaqqiʿ (Jaubert #27), a sketch of which appears all over the place, sometime with the edifice itself attributed to Fathy. He summarized its history in the statement:

> "In Egypt the *malqaf* is very developed and has long been a feature of vernacular architecture."

! بس كدا . That's all!

The *Wikipedia* article on Hassan Fathy (2018) states that:

> "The windcatchers are known in traditional architecture invented by Persian designers. In the Neoislamic architecture they are recognized as the works of Hassan Fathy. In Egypt the windcatchers are known as *Malqaf*."

! بس كدا . That's all!

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361 See Fathy, *Natural energy and vernacular architecture* (1986), and several other publications, as well as various articles and presentations by Leïla el-Wakil, including at the Berlin 2019 Conference on vernacular architecture world-wide.

For reasons that are unclear to me, Fathy did not exploit and reproduce the typical Cairo wind-catcher in any of the architecture he designed or inspired – **Pl. V1a**. Many modern writers on green architecture and the like ignore Fathy and have nothing of consequence to write on the Cairene wind-catchers anyway.[362]

Alas, Hassan Fathy never ventured to penetrate the history of Cairene wind-catchers, let alone the orientation of Cairene architecture on which they were situated. He concentrated on one or two examples, no more. As a direct consequence, the treatment of these in the burgeoning plethora of literature on vernacular architecture for green purposes either ignores the medieval Cairo wind-catchers altogether or treats them in passing, usually in one or two sentences. In not a single case that has come to my attention is any author aware that these devices were in widespread use in medieval Cairo or that there is a series of modern studies on them. The Israeli historian of Islamic art Hana Taragan points out that by Fathy's time the *malqaf*s of Cairo had almost disappeared and his use of them in New Gourna was "programmatic".[363]

James Steele, an eminent authority on Hassan Fathy and his works, presents in his 1997 book *An Architecture for the People* two interesting photos of the *bādahanj*es which are those Fathy never tried to imitate. These are: an extraordinary view of a ruinous *bādahanj* on the complex of Muḥibb al-Dīn al-Muwaqqiʿ (1350) – **Pl. Q2**, not known to me from any other source, and yet another full view of the *bādahanj* of the *Musāfirkhāne* (1779-88) – **Pl. R2**.[364] I cannot access the book itself, but

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[362] An exception is Al-Sallal & Meriem Rahman, "Vernacular architecture in MENA" (2019), with case-studies on ventilators in the Gulf, Sanaa, and Cairo (after Fathy) on pp. 40-49

[363] Taragan, "Architecture in fact and fiction: The case of the New Gourna village in Upper Egypt" (1999), esp. p. 172, and n. 10 on p. 178.

[364] Steele, *An Architecture for People: The Complete Works of Hassan Fathy* (1997).

the photos were re-used by the Egyptian architect Mohamed Mostafa Mahdy in his 2014 thesis on adapting the Egyptian residential code for climate change, which also treats of wind-catchers.[365]

Adherents of the school of Hassan Fathy can write whole articles about the *mashrabiyya*, in this case, dealing with the novel of the master with that word in the title,[366] and are forced to dismiss the *malqaf* in a sentence or two. Thus Leïla El-Wakil has written:

> "Le moucharabieh : pièce maîtresse de la stratégie architecturale. ... ... Réintroduire le moucharabieh dans l'architecture en lui redonnant sa fonction d'origine (et non pas en le pervertissant en paravent, chaise ou table), c'est faire un premier pas en direction de la reconquête des racines architecturales arabes. En effect, associé au *malqaf* ou capteur de vent,* il participe du système de ventilation naturel de la maison arabe, qui peut encore être amélioré par la distribution des cours et des jardins intérieurs, comme le décrit en détail Fathy dans son ouvrage tardif, *Natural Energy and Vernacular Architecture ...* ."
>
> * Footnote: "Ce dispositif en forme d'auvent en bois placé sur les toitures permet de diriger le vent à l'intérieur d'un bâtiment pour le ventiler et le refraîchir."
>
> "The *mashrabiyya* – master piece in architectural strategy. ... ... To reintroduce the mashrabiyya and give it once again its original function (not as a folding screen, chair or table), this would be a first step in the direction of assuring the reestablishment of Arab architectural roots. Actually, along with the *malqaf* or wind-catcher, the *mashrabiyya* participates in the natural ventilation system of the Arab house, which can be further improved by the arrangement of interior courtyards and gardens, as Fathy has described in his late work, *Natural Energy and Vernacular*

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365 Mahdy, *Applying architecture simulation tools to assess building sustainable design: Adapting the Egyptian residential energy code for climate change* (2014).

366 El-Wakil, "Présentation du Conte du moucharabieh (par) Hassan Fathy" (2017).

Architecture ... ."

* Footnote: "This device in the form of a wooden scoop placed on the roofs enables the wind to be directed towards the interior of the building in order to ventilate and freshen it."

If the space given here and elsewhere to the *malqaf* is, say, 0.1% of the space given to the *mashrabiyya*, this is far more than the *malqaf* has been afforded in most writings on historical Cairene architecture (and decorative art) by specialists. Hassan Fathy is partly to blame for this, because whilst he waxed enthusiastically about *malqaf*s, he never published a decent photo of one (there was no internet then), and he never included one in any of his architectural projects. I do not know why, but I would not be writing this if he had.

A charming computer-generated video featuring an (Ancient-)Egyptian-type wind-catcher in a (modern) village scene was put online by Google Doodle in 2017 on the occasion of Hasan Fathy's 117th birthday.[367]

Nelly Hanna

The prolific Egyptian historian Nelly Hanna in her 1991 book on the average Cairene household in the 17th and 18th centuries mentions *malqaf*s a couple of times in passing.[368] Her 1983 history of the port of Būlāq, which sprung up in the 15th century as a result of the Nile changing course, does not mention the rather prominent *bādahanj*es featured in the *Description de l'Égypte* and by Friedrich Hessemer and Félix Bocard –

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[367] Anonymous, "Hassan Fathy's 117th Birthday (23 March 2017)", at www.g—*—ogle.com/doodles/hassan-fathys-117th-birthday. This video was immediately circulated on Twitter by the Cairo-based German historian of science Karl Galle, together with a reference and link to my 1984 paper, and the ensemble attained some 11 'likes', which is not bad for two years: see https://twitter.com/Galle—*—Karl/status/844948086493499393.

[368] Hanna, *Habiter au Caire: la maison moyenne et ses habitants aux XVII et XVIII siècles* (1991), pp. 104 & 136.

Pls. C7 & E1 & H3 – and I wonder whether they are mentioned in any contemporaneous documents.[369]

Timothy Mitchell

Without going into too many details, and with considerable enthusiasm, although perhaps leaving some of his readers a little bewildered, the U.S.-based British political theorist and (advanced) student of the Near East, Timothy Mitchell, wrote in his 1988 book *Colonising Egypt* the following about the houses of pre-modern Cairo:[370]

> "In the case of pre-modern Cairo, for example, building usually involved opening up an enclosure, such as a courtyard enclosed by rooms or columns, polarised in many cases according to the direction of Mecca. This was so not only with mosques, but with ordinary housing as well, at least up until after the Ottoman conquest. In fact, it has been shown, for Cairo, that the orientation of building, of worshipping, and of receiving guests, the direction of Mecca, the path of the sun, the forces of the zodiac and the properties of the prevailing winds were all precisely correlated. With larger houses, the interior space carved out as courtyard and rooms was aligned precisely with such 'polar' directions and forces, rather than with the street or with neighbouring buildings."

I was much pleased to read this account, which is unique in the modern literature. Indeed, the "polar" directions were the direction of Mecca and the direction of the street-pattern and the direction of the wind-catchers, and all of these were indeed correlated. And all of these have been overlooked in most other modern writings about historical Cairo.

Elfriede Knauer

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369 *Eadem*, *An Urban History of Bulaq in the Mamluk and Ottoman Periods* (1983).

370 Mitchell, *Colonising Egypt* (1988), p. 54, and n. 67 on p. 189, citing S. D. Goitein's *Mediterranean society*, IV (1983), pp. 64-67) and my 1984 study.

The distinguished scholar of Classical Art, Elfriede R. Knauer (1926-2010), published in 1990 a significant study "Windtowers in Roman wall-paintings?"[371] The thoroughness of her scholarship ensured that she did not overlook relevant literature from other domains, and I was particularly pleased to see serious references to the Cairo scene, including due homage to the Musāfirkhāne. In fact, Knauer paid more attention to the Cairo wind-catchers than all of the historians of Cairene architecture put together, excepting, of course, the French scholars who documented the surviving palaces and houses of medieval Cairo.

Oleg Volkoff

Oleg Volkoff, in his book cited above, included several photos featuring wind-catchers that are not available elsewhere and made a nice remark which I repeat here because Volkoff deserves to be better known:[372]

> "Over every house in Cairo there yawned the opening of the famous *malqaf*. Leo Africanus ... . Prosper Alpini describes it more precisely ... . Open toward the north, the *malqaf* is the indispensable addition to every, even the most modest, house. It captures the cool breeze from the north in order to lead it into the interior of the houses, and plays the same role as the ventilation funnels of modern ships."

Suʿād Māhir

Suʿād Māhir Muḥammad (1917-1996) was not only the leading non-Western-trained Egyptian historian of Islamic art and architecture in her time but she was one of the few scholars in those disciplines who realized that scientific instruments were to be considered as scientific works of art and that certain historical scientific writings might be important for Islamic art and architecture. I remember with pleasure lecturing on the

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371 Knauer, "Windtowers in Roman wall-paintings?" (1990). See now Daniel, Architectural orientations in the papyri (2010), pp. 142-143.

372 Volkoff, *1000 Jahre Kairo* (1984), p. 139.

astrolabe and talking about orientations to her students at Cairo University in the mid-1970s. (Cairo University was the very place where Carlo Alfonso Nallino, author of perhaps the best articles on Islamic astronomy that have ever been written, had lectured on the history of Islamic astronomy in 1911.)

Suʿād Māhir authored a multi-volume work in Arabic on medieval Cairene mosques and mentioned *malqaf*s where appropriate, even giving the dimensions of the apertures.[373] She also authored a book in Arabic on Egyptian navigation and naval warfare.

Guy Petherbridge

The distinguished Australian-born book conservator, codicologist, and student of Greek and Islamic book history, Guy Petherbridge, published in 1978 a ground-breaking and richly-illustrated chapter on vernacular architecture in the Muslim world. He referred to the Cairo wind-catchers and included an enigmatic image, actually from the *Description de l'Égypte* – see above.[374] His caption to our **Pl. C16** read:

> "Cairo impressed travellers by its multi-storeyed houses on the banks of the Nile [*sic*], with their projecting screened balconies and wind-scoops rising from the roofs to channel the prevailing north breezes into the rooms beneath."

I have shown in **Ch. 6** how this image (actually a detail from an engraving of the lake of Ezbekiyya found in the *Description de l'Égypte*) was further misinterpreted by myself in 1984.

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373 Māhir, *Masājid Miṣr wa-awliyā'uhā al-ṣāliḥūn* (1971), III, 14, 169, 170.

374 Petherbridge, "(Islamic) vernacular architecture – The house and society" (1978), esp. p. 203 (even mentioning ʿAbd al-Laṭīf al-Baghdādī, but not his remark that rarely a house was to be seen without a *bādahanj*), and fig. 6 after p. 176. See already n. 234.

Doris Behrens-Abouseif

The specialist in Islamic architecture Doris Behrens-Abouseif in her 1989 introductory book on Islamic architecture in Cairo[375] has one image from the *Description d'Égypte* showing wind-catchers on three different kinds of Cairene houses, together with a limited discussion:

> "An air shaft, the *malqaf*, had been used in Egypt since Pharaonic times. This shaft was behind the wall of the main *iwan* and connected at roof level with a sloping vent oriented to the north. ... "

In her 2007 monumental book *Cairo of the Mamluks: A history of the architecture and its culture*, the same author is unaware of the studies of the triumvirate on wind-catchers and overlooks this standard feature of the architecture of Mamluk Cairo.[376] There are, of course, sections on all other aspects of Mamluk architecture, even what might be labelled vernacular.

On the other hand, it is true that very few survive on any monumental Mamluk architecture in Cairo; only one illustration in Doris' book shows a couple of *bādahanj*es *malplacés* on the roof of the Sultan Qalāwūn complex, and although they clearly do not belong there as they are, they cannot be permanent constructions – **Pl. N9**. It seems probable that they have simply been "parked" there, albeit on solid and secure foundations, and unhappily facing perpendicular to the main direction of favourable winds but sheltered from those winds anyway by the substantial base of the minaret.

An image by one Hakim Misr (حكيم مصر) that has recently appeared on a Facebook site Hikayt Athr (حكاية اثر) shows another view of the roof of this

[375] Behrens-Abouseif, *Islamic architecture in Cairo* (1989), p. 35.

[376] Behrens-Abouseif, *Cairo of the Mamluks: A history of the architecture and its culture* (2007). The only illustration of *bādahanj*es on a Mamluk building is pl. 78 on p. 132.

complex, not featuring the *malqaf*s, but, rather, a series of small sky-lights – **Pl. N9a**.[377]

J. Lennart Berggren

Len Berggren is a personal friend and close colleague who has done outstanding original research in the history of Islamic mathematics. His *Episodes in the Mathematics of Medieval Islam* (1986/2016), intended for a more general reader, was in the tradition of the famous *Episodes from the Early History of Mathematics* (1964) and *Episodes from the Early History of Astronomy* (2001) by our joint teacher (by osmosis) at Yale University, Asger H. Aaboe (1922-2007).[378] Len had the good taste to include aspects of practical Islamic astronomy, whereas most histories of mathematics ignore mathematical astronomy, even though it is there that one finds advanced trigonometry and 'mathematical methods' such as interpolation. 'Practical astronomy' was one of the few disciplines where Islamic mathematics was actually put into practice, inheritance rules and geometrical designs and architectural constructions such as the *muqarnas* being the others.

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377 To access the site google "mo.hakimmisr & 524201894713357". For a new study of illumination in historical Cairene religious architecture see n. 355.

On the theme of illumination in religious complexes see now Rawan Ahmed Adil Ali Mohammed, عناصر الاضاءة المعمارية في مدارس ومساجد القاهرة الباقية من زمن المماليك البحرية/ *Elements of architectural illumination in Cairo schools and mosques surviving from the Bahri Mamluk period*, Master's thesis (in Arabic) in Islamic Archaeology, Ain Shams University, 2015.

378 On Asger Aaboe and his achievements see my obituary notice "Asger Aaboe (1922-2007), in *ISIS* 98 (2007): 796-798, at www.academia.edu/34695181/.

Thus Len presented an overview of the *Very Useful Tables* of Ibn Yūnus, for which he used my 1973 article. Alas, due to an oversight, Len concluded from that paper that: [379]

> "Ibn Yūnus did not tell the Cairenes in which direction they should orient their ventilators. Rather, the book gave the altitude of the sun when it was in the azimuth of the direction everyone used for orienting ventilators. This is strange enough, but even stranger is the direction the Cairenes used (and Ibn Yūnus prescribed) for orienting ventilators, namely the direction of the rising sun at the winter solstice, which Ibn Yūnus calculated to be 27°30′ south of east, whereas modern data suggest that the optimal alignment for the winds in Cairo is about 70° south of east. However, recent studies by D. A. King show that in the medieval Islamic world a tradition of folk astronomy associated the direction of the rising sun at the winter solstice with certain winds. Thus this part of Ibn Yūnus' treatise shows a blend of folk astronomy with sophisticated calculations that is one of the pleasures of this field of historical investigation."

Len is certainly right about the pleasure one can have researching historical materials of this kind, but he has misunderstood what I wrote in 1973, probably because it was wrong. What I wrote was this:[380]

> "The table (for the azimuth of the *bādahanj*) is based on an azimuth of 27°30′ S of E, that is, the azimuth of the rising sun at the winter solstice. It is understood that the back of the ventilator should face this direction, and that the front should be exposed to the winds from the north-west. The azimuth of the rising sun at the winter solstice is a very nice direction, long popular amongst the Egyptians, but it is far from the direction which would afford optimal orientation for a ventilator in Cairo. (Footnote: Northerly winds are more numerous in Cairo at all seasons. From a study of the wind directions there over an 18-year period [I.D. 1117, pp. 252-256], I calculate that the "resultant", which would seem to correspond to an

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[379] Berggren, *Episodes in the Mathematics of Medieval Islam* (1986), pp. 179-181, and 2nd edn. (2016), pp. 213-214. I saw this passage in 2019 for the first time!

[380] King, "Ibn Yūnus' *Very Useful Tables*" (1973), pp. 371-372.

> optimum orientation, is about 75° S of E.)"

Let me correct the unhappy mess which I published in 1973:

> "The table (for the azimuth of the *bādahanj*) is based on an azimuth of 27°30′ S of E, that is, the azimuth of the rising sun at the winter solstice. **CORRECT**. It is understood that the back of the ventilator should face this direction, **CORRECT, BUT IT IS THE AXIS AT THE BOTTOM OF THE BACK OF THE SCOOP WHICH FACES WINTER SOLSTICE** and that the front should be exposed to the winds from the north-west **WRONG. THE PERPENDICULAR DIRECTION WOULD BE NORTH-EAST BUT THE WINDS DO COME FROM THE GENERAL DIRECTION OF NORTH-WEST**. The azimuth of the rising sun at the winter solstice is a very nice direction, long popular amongst the Egyptians, **CORRECT** but it is far from the direction which would afford optimal orientation for a ventilator in Cairo **WRONG**. (Northerly winds are more numerous in Cairo at all seasons. From a study of the wind directions there over an 18-year period [I.D. 1117, pp. 252-256], I calculate that the "resultant", which would seem to correspond to an optimum orientation, is about 75° S of E. **I AM NOT SURE THIS WAS A GOOD IDEA – IN ANY CASE, THE RESULT WAS NONSENSE**)"

There was thus considerable confusion in what I wrote in 1973, and in my defence I can only say that I was young and had no clear idea of what was going on with the *bādahanj*es. It was at the Institute of Fine Arts in New York in the early 1980s, when I was measuring mosque orientations in Cairo (and elsewhere from al-Andalus to China) – necessarily from inaccurate published plans –, that I realized that the wind-catchers are open toward a direction that is perpendicular to winter sunrise at 27° S of E, which direction was often used a *qibla* in medieval Cairo, even though my friend Ibn Yūnus had calculated it as 37° S of E. It did not take long to further realize that the entire Fatimid city, whose roughly orthogonal street-plane was aligned parallel to the Red Sea Canal, was also aligned with the wind-catchers. But the Canal at that location was perpendicular to the *qibla* of winter sunset. And these wind-catchers were not only aligned with the walls of the buildings on which they were situated just so that they would look nice (skew is bad). They were erected in this way

also because of considerations of the local folklore relating to the winds. So they looked nice because they fit nicely on the roofs, and their orientation concurred with local folklore, but not quite: to fully achieve this double aim, they had to be open on the west side, and closed on the east side. This is what the medieval Egyptian astronomical texts prescribe.

These realizations led me to prepare the paper "Architecture and astronomy: The ventilators of medieval Cairo and their secrets" for the *Festschrift* for Prof. Franz Rosenthal, not least because in the meantime he had published "Poetry and architecture: The *bādhanj*" (1977).

Renata Holod

Renata Holod is a distinguished American historian of the art and architecture of the Islamic world. (We met at the University of Pennsylvania in the eventful summer of 1968 and graduated the same year 1972 from different, some say rival, universities.) As a professor, mainly at UPenn, Holod has supervised over fifty doctoral theses from students in a range of fields, including History of Art, Architecture, Urban Planning, Religious Studies, Middle East Studies, and Art and Archaeology of the Mediterranean World. She also bears the distinction of being the only serious investigator to have used the first two modern studies of the *bādahanj*, namely, Rosenthal 1978 and King 1984, this in a 1986 academic paper entitled "Defining an Art of Architecture".[381]

In addition to presenting various architect's diagrams based on orthogonal grids or geometric patterns, Holod presented the diagram of Najm al-Dīn

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381 Renata Holod, "Defining an Art of Architecture" (1986), pp. 26-32, at https://s3.us-east-1.amazonaws.com/media.archnet.org/system/publications/c—*—ontents/3626/original/DPC0224.pdf?1384775798. The two quotes are from pp. 29 and 27-28. I have corrected the name of the author of the anonymous treatise on 100 instruments from my first candidate Ibn al-Sarrāj to the actual author Najm al-Dīn al-Miṣrī: see n. 862.

al-Miṣrī for the construction of a *bādahanj* viewed from above, taken from the Dublin manuscript and first shown in King 1984. She explained:

> "The additional bonus of familiarity with the literature of Islamic science is the fact that one finds information about aspects of architecture in rather unexpected places. For example, instructions for the construction of a wind tower are found in (a manual on 100 different kinds of astronomical instruments) by (the early-14th-century Cairene astronomer) Najm al-Dīn al-Miṣrī ... ."

In order to show the way in which architecture found a place in *belles-lettres*, Holod presented some of the poems about *bādahanj*es from the anthology of al-Ghuzūlī, translated in Rosenthal 1978:

> "We can no longer speak only of building in some incohoate realm of traditional, natural or historic architecture, without the ability to conceptualise and to create discourse about it. So pervasive was the consciousness of the built environment and of the process of building that it filters into the realm of *belles lettres.* An example has been identified in the case of the wind tower in Egypt. Apparently this architectural importation and innovation so preoccupied the imagination of the literati that scores of poems were composed utilising the wind tower as metaphor for the various states of love. [... Three examples are presented. ...] In al-Ghuzūlī's *Maṭāliʿ al-budūr,* an anthology of cultural history, a whole chapter is devoted to the *bādahanj.* This work as well as the individual poems reflect the integration of this new feature of architecture into the regional culture of the Arab world from the 11th to the 14th century."

This ideal use of supplementary historical witnesses to medieval architectural features was particularly appropriate for an edited volume *Architectural Education in the Islamic World*. Holod is the only historian of Islamic architecture known to me to have availed herself of the two studies, which at that time were unique of their kind. If she had specialized in the history of architecture in Islamic Egypt, I have the feeling I might not be needing to write these lines now. In **Ch. 16** we shall return to her comments on the *qibla*.

Michael Meinecke

The German scholar Michael Meinecke (1941-1995) published the most detailed survey of Mamluk architecture ever written. His Mamluk architecture in Egypt and Syria (in German) was published in 1992 and necessarily included buildings in Syria and Palestine.[382] That Michael did not mention a single wind-catcher in Cairo is all the more surprising because we spent considerable time together in Cairo in the 1970s talking about such things.

Caroline Williams

For many serious visitors to Cairo, the book by the American Islamic architecture expert Caroline Williams entitled *Practical guide to the Islamic monuments of Cairo* is their first and constant companion. Caroline, unlike many of her colleagues in Cairo, was not afraid of *malqaf*s and noted several of them.[383] Important was her generalization, which is "right on", namely (my emphasis):

> " ... **the *malqaf*, the wind scoop, ... was a standard feature of Cairene architecture, but few survive now.** It resembles the head of a stair-case and is designed to capture the cooling wind from the north. The design goes back to pharaonic times."

The earlier (?) guide of Richard B. Parker and Robin Sabin, dated 1974, contained not a word on the wind-catchers, even ignoring the splendid one

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382 Meinecke, *Die Mamlukische Architektur in Ägypten und Syrien (648/1250 bis 923/1517)*, Teil I: Genese, Entwicklung und Auswirkungen der mamlukischen Architektur & II: Chronische Liste der mamlukischen Baumassnahmen (1992). Part I deals with the genesis, development and influence of Mamluk architecture, Part II presents an ordered chronological list of Mamluk building undertakings, with extensive bibliography.

383 Williams, *Practical guide to the Islamic monuments of Cairo* (2008 edn.), p. 188.

in the “18th century confection in the Mameluke style” which is our Musāfirkhāne Palace.[384]

Yehia Wazeri

The Egyptian specialist on Islamic architecture Yehia Wazeri mentioned the *malqaf*s in his writings on Cairene architecture.

First, in his 2001 doctoral thesis entitled *Natural Cooling Systems* Yehia Wazeri discussed the *malqaf* as a means for improving the thermal performance of buildings in North Africa:[385]

> “A study was carried out in August, 1999 and 2000 to evaluate and improve the thermal performance of wind catchers. Four wind catchers in different buildings in Cairo were chosen to meet the requirements of the field study. The four wind catchers are different in shape, size, orientation and building materials as described below. ... ”

The study alas included only one historical *malqaf*, namely, that of the house of al-Sinnārī (Jaubert #56), and the thermodynamical results were not remarkable.

In his later book in Arabic on Islamic architecture and the environment, Wazeri presents a general discussion of *malqaf*s throughout the Islamic world, focussing on those on the houses of al-Sinnārī and al-Suḥaymī (Jaubert, #56 and #46 & #57).[386]

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384 Parker & Sabin, *A practical guide to Islamic monuments in Cairo*, Cairo: American University in Cairo, 1974, esp. p. 59.

385 Wazeri, *Natural Cooling Systems – An approach for improving the thermal performance of buildings in North Africa (2001)*, esp. pp. 58-59 (Bayt al-Sinnārī), 60-65 (3 modern examples) and 76-78 (conclusions). I am grateful to Prof Wazeri for providing me with copies of the relevant sections of his thesis.

386 *Idem*, العمارة الاسلامية والبيئة / *Islamic architecture and the environment* (2004), pp. 116-121.

Hisham Mortada

In his 2003 book *Traditional Islamic Principles of Built Environment*, the KSA-based Egyptian architect Hisham Mortada mentioned a few wind-catchers in various locations. Curiously he does not mention the *qibla* or orientation.[387] The same author has published *Cultural Diversity of an Ancient Urban Element: The Cul-De-Sac*.

Attia & De Herde

A 2009 joint study by Shady Attia, an architectural engineer and professor of sustainable architecture at the University of Liège, and his colleague and former doctoral advisor André De Herde, professor emeritus of architecture, architectural engineering and urbanism at the Catholic University of Louvain-la-Neuve, was entitled "Designing the *malqaf* for summer cooling in low-rise housing, an experimental study".[388] Here the authors have no obvious experience with any Cairene examples, and deal in general terms with *malqaf*s that face north (which is not quite the case in medieval Cairo). They summarize their worthwhile intentions as follows:

> "The *malqaf* or wind-catcher is Egyptian vernacular archetypal device that traps the wind into the building. For centuries, the *malqaf* has been used as a viable solution to ensure natural ventilation. However, for the last 50 years, Egyptian practice has failed in combining traditional architectural devices into new techniques that could lead to sustainable and energy aware buildings. In Egypt, more than half of the urban peak load of energy consumption in the mean time is used to satisfy air conditioning demands alone. Therefore, the objective of the research is to develop a viable passive alternative to active cooling by exploring the potentials and design

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387 Mortada, *Traditional Islamic Principles of Built Environment* (2003). See pp. 120, 138, 144, 145, 146, 158 on wind-catchers.

388 Attia & De Herde, "Designing the Malqaf for Summer Cooling in Low-Rise Housing" (2009).

> parameters of wind-catchers as solutions for passive cooling and natural ventilation during the summer season for low-rise housing."

The reader may consult their work to see their conclusions.

Nermine Mohamed & Waleed Ali

A 2014 study "Traditional residential architecture in Cairo from a green architecture perspective" by Nermine Abdel Gelil Mohamed & Waleed Hussein Ali mentions *malqaf*s as a standard feature of medieval houses and devotes a substantial section to their function under the rubric "wind energy".[389]

Salih Zaki

An undated study by Salih Zaki on traditional urban fabric and architecture in Cairo does not specifically mention any *malqaf*s and maintains that in the 20th-century *manwar*s or light-shafts were introduced, open to the north, to additionally function "as a ventilator or a *malqaf* for the house".[390]

Nasser Rabbat

One of the leading scholars of the history of Egyptian architecture, Nasser Rabbat, when writing in 2002 about the perception of architecture in Mamluk textual sources, was unfortunately unaware of Franz Rosenthal's study. However, he did mention the treatise of al-Ghuzūlī (d. 1412),[391] confirming that it

> "integrates in an unprecedented way a number of architectural elements, such as fountains, (water) tanks, and wind catchers, in the list of topics that

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389 Mohamed & Ali, "Traditional residential architecture in Cairo from a green architecture perspective" (2014), esp. pp. 10-11.

390 Zaki, "Ch. 3: Traditional urban fabric and architecture" (in English and Arabic).

391 Rabbat, "Perception of architecture in Mamluk sources" (2002), p. 171, n. 42.

> an *adīb* needs to be able to discuss and to summon literary quotations about in his function as a literary companion."

This sure sounds like an ideal topic for a doctoral dissertation.

Nicholas Warner

The American architect and architecture historian Nicholas Warner, in his splendid 2005 book *Monuments of historical Cairo*, presents an introductory text which goes far beyond the *catalogue raisonné* or ordered survey of individual architectural monuments of medieval Cairo. His introduction is essentially a cartographical history of Cairo, the first of its kind, and most useful it is. It lays a new foundation for the catalogue of historical buildings that follows, each entry with a basic description and a full bibliography.[392]

In the notes to his *catalogue raisonné* Warner does include various references to specific buildings with wind-catchers or with inner walls inclined to outer walls, citing King 1984 and/or Jaubert 1995 in the bibliographies appended to the descriptions of certain buildings where appropriate.

Various Iranian scholars, including Mehdi Bahadori

Iranian scholars tend to be more in tune with modern literature than some other groups. First of all, Mehdi Bahadori (1933-), now professor of mechanical engineering at Sharif University of Technology in Tehran, published an article "Passive cooling systems in Iranian architecture" in *Scientific American* already in 1978. He thereby attracted attention to the role of Iran in exploiting wind-energy and ensured that the Iranian wind-catchers were known to the world scientific community. (It is somewhat ironic that at the same time Rosenthal & King were writing about the Cairene wind-catchers in journals which have very limited circulation so

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[392] Warner, *Monuments of historical Cairo* (2005).

that their publications attracted virtually no attention at all.) Forty years later Mehdi Bahadori is still actively involved with his subject.

The Iranian scholar Ali Mahyari in his 1996 doctoral dissertation "The Wind Catcher" mentions in passing the 1977 study of Franz Rosenthal; his thesis is important, and unique at the time, in presenting brief discussions of wind-catchers in various countries.[393] Also, Mehdi Bahadori and Alireza Dehghani-sanij in their 2014 book *Wind Towers – Architecture, climate and sustainability* feature the medieval Egyptian poetry gathered by Rosenthal, if not the studies of King and Jaubert.[394] A reference to Ibn Yūnus is a false lead.[395] The Persian poetry on wind-towers from the 10th century onwards collected by the Iranian authors complements the Arabic poetry collected by Rosenthal (and later Masarwa). Even a rare image of the wind-catcher on the Bayt al-Suḥaymī is included (see above – **Pl. Q5**). Our Iranian colleagues are better informed on the Cairene scene than many other writers.

Most studies of wind-catchers in the Islamic world have been conducted by Iranian scholars familiar with the situation in Iran. There is a substantial bibliography, some of which is gathered below. An exception for the Iranian wind-towers is the renowned British expert on historical and

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393 Mahyari, "The Wind Catcher – A passive cooling device for hot arid climate" (1996), p. 45

394 Bahadori & Dehghani-sanij, *Wind Towers – Architecture, climate and sustainability*, pp. 42-45. See also Masarwa, "Urban architecture and poetry" (2017), p. 116.

395 The source is supposedly Bernard O'Kane's 1976 study of the Madrasa Al-Ghiyāṯīyya at Khargird", which does mention *badgīr*s but not those of Cairo. The reference of Bahadori *et al*. to this study is doubly curious because, as far as I am aware, the Cairo-based historians of Islamic architecture are generally loath to ever mention wind-catchers, orientations or *qibla*s in Cairo. Bahadori *et al*. were clearly citing Rosenthal, not O'Kane.

contemporary vernacular cooling systems, Susan Roaf, some of whose writings are listed separately in the bibliography.

Mehdi Bahadori and Alireza Dehghani-sanij are the only authors I have found who have presented a substantial amount of materials for a history of wind-towers in Iran – this is summarized at the end of **Ch. 1** above. Pursuing this topic further, a necessary task, would call for a specialist in historical literature dealing with Iran and ranging over a thousand years. The literature exists in abundance; the specialists are few indeed.

Missing the mark

In a 1984 study of residential architecture in Mamluk Cairo, the Egyptian historian of Cairene architecture Laila Ibrahim avoided all mention of the wind-catchers which some observers had recorded were to be found on most private houses.[396] On the other hand, in a section headed "Ventilation", aerating latrines is discussed and documented:[397]

> "Ventilation was a main concern in the medieval period, and latrines and drainage were also given special attention. There were latrines on each storey and attached to every unit. The latrines on the upper storeys had small perforated domes for ventilation and those on lower storeys had flues behind the seats that reached to the roof. In palaces, seats were made of marble and latrines even had marble mosaic floors."

Curiously, we find not a word about *bādahanj*es. The "small perforated domes" on the roof are new to me.

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[396] Ibrahim, "Residential architecture in Mamluk Cairo" (1984). The topic is further overlooked in O'Kane, "Domestic and religious architecture in Cairo" (2000) in a *Festschrift* for Laila Ibrahim.

[397] On this subject see now Rousset, "Lieux d'hygiène et lieux d'aisance au Moyen âge en terre d'Islam" (2016).

Ibrahim's 1977 study "Middle-class living units in Mamluk Cairo" is based on six *waqf* documents,[398] but the word *bādahanj* apparently does not occur in these. Ibrahim at some stage became aware of the term because in her 1990 book with Muhammad Amin entitled *Architectural terms in Mamluk documents* (in Arabic), the term بادهنج, *bādahanj*, is listed.[399]

Hanaa Mahmoud Shokry, in a 2012 study of Islamic urbanism and access regulation, focussing on medieval Cairo, describes every part of a traditional house except the wind-catchers.[400]

On the site *1001 inventions* we find brief mention by Lotfi Lahlou in 2018 of the *malqaf* / *bādahanj* as an Islamic invention.[401] A photo shows an Iranian wind-tower and the text quotes ʿAbd al-Laṭīf al-Baghdādī and his observations on the omnipresent Cairo wind-catchers *ca*. 1200. According to Lahlou, the openings of these catchers faced the *qibla*. Inevitably, there is no bibliography.

There are countless works on medieval architecture in Cairo which do not mention the wind-catchers at all, such as the following.

The Grove Encyclopedia of Islamic Art and Architecture

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398 Ibrahim, "Middle-Class living units in Mamluk Cairo: Architecture and terminology" (1977).

399 Amin & Ibrahim, *Architectural terms in Mamluk documents* (in Arabic), p. 19, cited in Jaubert, "Capteurs de vents", p. 19.

400 Shokry, "Islamic urbanism and access regulation as a guide to the future – The case of medieval Cairo" (2012).

401 Lotfi Lahlou, at https://1001inventionsmusulmanes.net/tag/ملقف/ (2018). There is no reference to any wind-catchers or wind-towers anywhere in the Muslim world in the volume al-Hassani, ed., *1001 inventions – Muslim heritage in our world*, which focusses on Muslim achievements that had influence in the modern world.

The monumental 3-volume 2,000-page *Grove Encyclopedia of Islamic Art and Architecture* edited by Johnathan Bloom and Sheila Blair and published in 2009 by Oxford University Press, was hailed as "the most comprehensive reference work in this complex and diverse area of art history".[402] Suffice it to say there is not a word about the 1,000-year-old tradition of the wind-catchers of medieval Cairo in the article "Wind Catchers", where the discussion is restricted to Iran. Nor is there any mention of them in the section on Egypt in the article "Vernacular Architecture", which has a useful bibliography on everything other than wind-catchers in Egypt.

It is not the two editors who are at fault here. The problem lies with the way the *Encyclopedia* was conceived, to which we shall return when we discuss the fact that the omission of the *qibla* is far more serious than the omission of wind-catchers. In the discussion of Cairene mosque orientations in **Ch. 15-16**, the two editors deserve nothing but praise for recognizing that medieval textual sources can be extremely useful in investigating the orientation of medieval architecture and its significance.

Ahmed Sedky

The Egyptian urban development consultant Ahmed Sedky, in his 2001 article on the changes in Cairene domestic architecture after the Ottoman conquest, did not mention the wind-catchers at all, let alone the fact that during this time the once abundant wind-catchers slowly disappeared.[403] A glance at the 18th- and 19th-century paintings and the late-19th- and early-20th-century photos in **Part II** will confirm this. There must exist some documentation of the reasons for this, but I do not know where.

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402 Bloom & Blair, eds., *Grove Encyclopedia of Islamic Art & Architecture* (2009).

403 Sedky, "The factors influencing the change in Cairene domestic architecture after the Ottoman conquest" (2001).

Ahmed Sedky is also the author of a monumental study *Living with Heritage in Cairo – Area conservation in the Arab-Islamic city*, published by the American University of Cairo Press in 2009. Confronted with all of the problems confronting modern Cairo and any attempt to save any historical regions, one may be allowed to forget about the *bādahanj*es of medieval Cairo for a short while.[404]

Hossam Ismail

In 2005 the Egyptian specialist in Islamic antiquities Hossam Ismail published an article with the promising title "Historical introduction to Islamic architecture in Old Cairo" for a more general audience of the journal *Museum International*.[405] For such an audience there was apparently no need to mention a single work on the history of Cairene architecture. However, Ismail did know about the existence of *malqaf*s for he wrote:

> "As a rule, the northern *īwān* contained a *malqaf* (a wind scoop built on the roof for directing cool breezes into the rooms below) for the purpose of conditioning the air in the reception hall. ... ."

Would that all specialists on Cairene architecture knew this.

S. Suleiman & B. Himmo

In a 2005 article with a promising title "Direct comfort ventilation. Wisdom of the past and technology of the future (wind-catcher)", S. Suleiman and B. Himmo try to present an overview of wind-catchers in the Near East. The study is one of those in which the books and articles in the bibliography are cited in the text without any page numbers, an unfortunate custom which is unacceptable in the Humanities, and which

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404 Sedky, *Living with Heritage in Cairo – Area conservation in the Arab-Islamic city* (2009).

405 Ismail, "Historical introduction to Islamic architecture in Old Cairo" (2005).

reinforces the the divide between the Humanities and the Rest. The information on ancient and medieval Egypt is sparse and somewhat confused:

> "The theme of *malqaf* goes back to very early historical ages of the Assyrians in Iraq (Kay & Zandi, 2004) and of the ancient Egyptians. The latter used it in their houses in Tel-Amarna, these houses were seen in the drawings carved on tombs dating back to the nineteenth dynasty between 1200 and 1300 B.C. that *malqaf* had two roof openings one is facing the breeze while its opposite vacuum the hot air out (Fathy, 1986).
>
> "*Malqaf* was spread, in the middle Islamic age in multi-storey buildings in Al-Fustat city in Cairo, where nearly every house used it though the surviving ones can be counted (King, 2004).
>
> "The *malqaf* served residential buildings in the Arabian Gulf in the nineteenth century, and spread to Iran especially in Yazd city in the Iranian plateau in the same period (Herdeg, 1990). The horizontal cross section of *malqaf* took several shapes: square, rectangle, circular and there were few types of octagonal section in Iran (Norton, 1997), dividers to catch wind from any directions (Fathy, 1986)."

There are numerous problems with this quote, and one can hope that nobody ever cites it. Particularly disturbing is the attribution to this author (2004 revised version of 1984 paper) of the statement (of al-Baghdādī *ca*. 1200) that nearly every house in medieval Cairo had a *bādahanj* (they were not called *malqaf*!!), as well as the absurd notion that *malqaf*s (actually *bādgīr*s!!) "spread to Iran" in the 19th century from the Gulf!

James E. Lindsay

The American Near East historian, James E. Lindsay, in his straightforward, easy-to-read, popular overview on daily life in the

medieval Islamic world,[406] mentions our wind-catchers (as many learned books on Islamic architecture do not):

> "Another means of ventilation (besides the *mashrabiyya*) was the wind catcher, or *malqaf*. A wind catcher functioned as a kind of reverse chimney / swamp cooler in that it was composed of a shaft that rose above the building's roof. The opening of the shaft was positioned to catch the prevailing winds of the region and force then down into the building, often flowing over pools of water or screens that were dampened with wet fabrics."

Most appropriately an illustration from Edward Lane's *Manners and Customs of the Modern Egyptians* is found near to this text and this shows a substantial *malqaf* on a two-storey house – see **Pl. F9**. The reference to screens "dampened with wet fabrics" calls to mind the story of Caliph al-Muqtadir in the harem in Baghdad – see **Ch. 4** – but I have not seen this practice referred to anywhere else in the primary sources. Lindsay also uses illustrations from the *Description de l'Égypte* to enrich his book, something one seldom sees in publications that are not in French.

Akel Ismail Kahera

Akel Ismail Kahera is a Muslim writer who has confronted the enigma of historical *qibla* determinations.[407] Originally from Brooklyn, he is a scholar of Near Eastern Studies and Architecture, specialist in mosque architecture in the US, who has taught recently in Texas and then Qatar. He discusses various historical situations including Cairo, so we include his work here. He is well informed on issues in the sacred law of Islam, as

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406 Lindsay, *Daily life in the medieval Islamic world* (2005), esp. p. 127.

407 The important article by an earlier group of Muslim authors writing in English – M. S. M. Saifullah & M. Ghoniem & ʿAbd al-Rahman Robert Squires & M. Ahmed, "The Qibla of early mosques: Jerusalem or Makkah?" (2001), at www.islamic-awareness.org/History/Islam/Dome_Of_The_Rock/q—*—ibla.html – was concerned, as their title suggests, mainly with the problem of the earliest *qibla*.

his title suggests: “The accuracy of the *qibla* axis: a legal debate”.[408] He cites some publications of Suleiman Bashear, Michael Bonine, David King and Christel Kessler – never before seriously cited by a Muslim author, as far as I know – and mentions the situations in Cordóba, Fez, Qairouan and Cairo. (For Cordóba he is unaware that the Grand Mosque does not face due south, although people still say it does, and that its curious orientation is now explained.) However, he has unfortunately not availed himself of the *Encycyclopedia of Islam* articles “Mecca as the centre of the world” (folk astronomy and sacred geography) and “Ḳibla, ii” (mathematical geography), so that he barely mentions finding the *qibla* by astronomical horizon phenomena or calculating the *qibla* using geographical data. For Cairo he quotes three of al-Maqrīzī’s *qibla*s attested in architecture in that city by means of Christel Kessler’s later work, but he does not refer to my 1984 paper on basic orientations in Cairo.

In short, Kahera’s study is important and could serve as a guide to further research. Most Western writing on the subject has not paid sufficient attention to the legal aspects of the *qibla* problem, with the exception of A. J. Wensinck’s article “Ḳibla. i. Legal aspects” in the *Encyclopedia of Islam* (1st & 2nd edns.) and Ahmed Dallal’s study of a legal controversy described by the 16th-century astronomer al-Tājūrī over mosque orientations and the *qibla* in Fez, which controversy is mentioned by Kahera.[409]

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[408] Akel Ismail Kahera, “The accuracy of the *qibla* axis (*inḥirāf al-qibla*): a legal debate”, (2014).

[409] Ahmad Dallal, *Islam, science, and the challenge of history* (2010), pp. 1-9. See n. 692 above.

Gehan S. A. Ibrahim

The Egyptian lecturer, author and researcher in Islamic Art and archaeology, Gehan S. A. Ibrahim (www.gehansaibrahim.com/) has recently published an interesting and rather unusual book on Muslim culture. It deals with "the ethics and virtues in various aspects of the lives of Muslims as read and interpreted from various sources such as Islamic literature, examples of art objects and outstanding architectural testimonies witnessing evidence of the integration of morals in ideas and themes."[410]

In her discussion of Islamic architecture, Gehan Ibrahim states the following about wind-catchers in the Islamic world in general and in Cairo in particular:

> "The vast majority of Muslim buildings have developed specific architectural devices for the purpose of producing healthy conditions for the dwellers of these buildings. Indeed, there are superb architectural solutions, like ventilators that could be spotted in Muslim architecture to produce enough airing into buildings. This is in addition to reducing the sufferings of the Muslims from the irritation of the heat. All have helped to shape the virtues of Muslim architecture. Although Islamic ventilators appear to have the same function in such a wide range of Muslim architectural buildings and in so many different building environments, they took various shapes and forms. Under the Muslim era, some were invented to catch the cool wind and direct it in the interior of the building. Other devices were used in the underground cellars intended as sitting rooms in the summer, like those in Iran and Iraq. The idea of ventilation to grab the cool weather in the summer is not a purely Islamic invention. It existed many ages before the Muslim era. The idea could be traced to the Ancient Egyptian times when ventilators with triangular side views appear on terraces of buildings for that purpose. Similarly, in the

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[410] Ibrahim, *Virtues in Muslim Culture: An interpretation from Islamic literature, art, and architecture* (2014), esp. pp. 219-220.

Hellenistic period, houses with open porches were planned to follow the same function. In Coptic houses, on the other hand, deep cellars were ventilated with clay tubes opening through the crown of the vault to the floor of the room above. Ventilators of the Muslim era also took various forms in respect to the region and climate they were used in. For example, in Iraq, where the weather is more continental than Egypt, the T-shaped hall plan to the south of the court of the house was another architectural layout to ensure cool ventilation into the house in the summer. However, in Syria, the living apartments were placed on the Northern side of the house to capture the most of the rays of the sun and to avoid the chilly winds.[81]

"In Egypt, alternatively, and in domestic architecture of the Muslim era, due to its very hot weather in the summer, all rooms in the house were often designed to face north to attract the cool wind coming from that direction. Air is admitted to rooms through wooden ventilators in the shape of prismatic tunnels slanting to the interior of the building called *malqaf* or 'catcher' erected above the ceilings.[82] In Muslim works of literature, these ventilator devices are described under different names, such as air shafts, wind catchers, *malqaf*s, or *bādahanj* and were explained to be found on the roofs of houses placed and oriented according to the study of the science of astronomy. The 10th-century Egyptian mathematician and astronomer Ibn Yūnus[83] (950-1009) indicated this fact. Similarly, in another treatise on the use of the sine quadrant that was copied in the 18th century and composed by an unidentified author Muḥammad Ḥattāta al-Fāraskūrī[84], it has been pointed out how to rely on astronomy in estimating the orientation of the *bādahanj*. By the mid-12th century, in Cairo, the time of the historian ʿAbd al-Laṭīf al-Baghdādī[85] (1162-1231) air shafts or *bādahanj* were very common in Muslim architecture and spread excessively in all Cairo.[86] The following excerpt shows how the *bādahanj* is built according to astronomical calculations:

> The Twelfth Chapter: on finding the azimuth of the *bādahanj*. Find the rising amplitude of the day-circle of Capricorn for the [latitude] of Mecca, and then move south by this amount (from the east point) and this will be [the azimuth of the] the *bādahanj*. God knows better."

[There follows a paragraph on Ibn Baṭṭūṭa with notes [88] & [89].]

Footnotes: 81 (Reference to Badawy 1958.) 82 (Another reference to Badawy 1958.)

> 83 (Biographical details on IY.) 84 (Reference to a Cairo manuscript with a reference to the *qibla* and the *bādahanj* (!).) 85 (Biographical details on al-Baghdādī.) 86 (Reference to Rosenthal 1977.) 87 (Reference to King 1984.) 88 (Biographical details on IB.) 89 (Reference to Gibb 1959.)

The text moves on, turning to a single illustration in the well-known *Maqāmāt* of al-Ḥarīrī (d. 1121/22),[411] fifty anecdotes about a hero of high education but doubtful morals, who on his travels uses his various skills to gain money from unwary victims. These "situations" (*maqāmāt*) in rhymed prose constitute a masterwork of literary genius, the manuscripts of which are richly illustrated. Gehan Ibrahim presents an architectural feature on the roof of a building as a wind-catcher, but that it is not. Rather, it is a skylight of the kind known in Cairo as *shakhshūkha* – **Pls. P3b & Q5a**. Apparently, no other illustrations in the al-Ḥarīrī manuscripts display this feature.

It is a sad fact that, unless I am mistaken, Badawy 1958, Gehan Ibrahim's primary source, remains the only reliable overview of house ventilation in the ancient Near Eastern world. It was of course ground-breaking in its time. But there is no reliable overview at all for the medieval Near East which would gives due treatment of Iran, Iraq, Syria, Anatolia and Egypt.

Now Badawy's remarks about the medieval Cairo wind-catchers were restricted to two sentences. Out of these Gehan Ibrahim has constructed a substantial paragraph. However, she overlooks the extensive references to wind-catchers in medieval Egyptian poetry even though mentioning the article in which they were discussed for the first time (Rosenthal 1977). She also introduces a curious reference to winter sunrise (quoting King 1984) which might leave any reader in total confusion. Nevertheless, **Gehan Ibrahim ranks as the only author in 30 years to recognize that this astronomical connection is interesting and worthy of mention, if**

[411] See, for example, the articles "al-Ḥarīrī" and "Maqāma" in *Enc. Islam*, 2nd edn.. The text was first edited by Caussin de Perceval (1819), who also published the observation reports of Ibn Yūnus (!). The standard English translation is by F. Steingass (1898).

not also historically important. Unfortunately, she chooses to cite a very late Egyptian astronomical source on the orientation of wind-catchers, whilst neglecting all other, more significant, earlier ones. Also, the link with the *qibla* is, alas, ignored.

Robert W. Daniel

A 2010 book by an author, Robert W. Daniel, a British papyrologist at the University of Cologne, deals with orientations in domestic architecture in Graeco-Roman Egypt. His study draws upon the situation in Pharaonic Egypt but happily does not entirely overlook developments in Muslim Egypt.[412] Daniel has used the studies of Rosenthal 1977 and King 1973/1984, but appears to have been unaware of Jaubert 1995.

(I find it curious that in a book on orientation in Egypt there is no mention of the archaeo-astronomical research on orientations in Ancient Egypt, but likewise one has to look far and wide for any book on historical Islamic architecture that contains anything at all about orientations, let alone about the archaeo-astronomical research on orientations of the Islamic world.)

Having dealt with the predominantly northern orientation of, and ventilation devices in domestic architecture in Ancient Egypt and the Graeco-Roman period, using predominantly linguistic evidence but also the available pictorial evidence, Daniel proceeds to Cairo in the late medieval period (how medieval depends on where you are). In an appendix on "narrow airshafts and wind-catchers", he first discusses part of the account of Prospero Alpino (1553-1617), presenting the Latin original and an English translation (compare **Ch. 4** above). Daniel is rightly suspicious of the sketch of a ventilation shaft and proposes that it might have been added by a later (18th-century) illustrator. He then singles out for further discussion the ventilation-shaft of the Mosque of al-Ṣāliḥ Ṭalā'iʿ (datable to 1160, Jaubert #17), alas no longer extant in its entirety

412 Daniel, Architectural orientation in the papyri (2010).

and not the best choice if one is choosing only one example. His account is based on Creswell, who is quoted directly, and who surmised that there must once have been a wind-scoop at the top end of the air-shaft. Given the dubious nature of Alpino's illustration, Daniel ventures to compare it with the conical air-shafts in subterranean hermitages near Esna and in Saqqara, dating from 550-630. He surmises that these once had a wind-scoop at ground-level; if not, they would have been ineffectual.

Daniel does not discuss in any detail any other Cairo wind-catchers but he is aware of several: he presents seven illustrations of historical Cairo wind-catchers, which is the more admirable because it is **far more than any other Western (or non-Western) scholar has published in 200 years**. These are (pp. 136-137):

1) Ezbekiyya Lake from *Descr. Égypte*, pl. 42 (detail).

2) View from Citadel *ca*. 1850 by Bernhard Fiedler, from Charlottenburg Museum, Berlin (not in **Part II**).

3) Gérôme, Prayer on the rooftops, Kunsthalle Hamburg, detail.

4) Palace of Alfī Beg, from from *Descr. Égypte*, pl. 52 (detail).

5) Villa of Ḥasan Kāshif, from *Descr. Égypte*, pl. 54 (detail).

6) Musāfirkhāne, fake composite photo from *al-Ahram*, 05-11.11.1998, with wind-catcher superposed over wall with *mashrabiyya* (معليش). (The webpage for the article Fayza Hassan, "Sinning by omission", from which this image was taken, is apparently no longer accessible.)

7) View inside the Musāfirkhāne, from King 1984.

Unfortunately, Daniel did not pursue the "treatise on the calculation of its optimal orientation written by the Egyptian astronomer, Ibn Yūnus, who died in 1009",[413] which would have led him away from north orientations to solstitial orientations and, in particular, the orientation of the Ancient

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[413] *Ibid*., pp. 138-139.

Egyptian / Roman Red Sea Canal at the site of al-Qāhira (which is counter-solstitial).

It is hardly surprising that this important contribution to the study of medieval Egyptian vernacular architecture comes from the pen of someone who works principally in a different era of Egyptian history, before Cairo existed. As Ernest Tatham Richmond (1874-1955), a British architect who spent some time working in Egypt then Palestine, stated in an eloquent and moving essay on Cairo's history and significance published in 1913:[414]

> "Cairo is to be identified with the spirit of change; Egypt with that of stability. Cairo looks always to the outer world for her life and her inspiration, while Egypt looks solely to what her river brings."

Abbas M. Hassan & Hyowon Lee & Uoosang Yoo

In 2015 an Egyptian Abbas M. Hassan and two South Korean environmentalist engineers, Hyowon Lee and Uoosang Yoo, published a curious paper aiming at being a comparative study of medieval Cairo and modern "clean energy" Masdar City in the Gulf.[415] They are typical of young scholars who ignore or deprecate previous orientalist studies. In a few cases, these new writings start by demolishing everything that (they think that) earlier orientalist authors have written. The same holds for other, related historical disciplines.

Our three authors extol the virtues of the *malqaf*s of medieval Cairo, about which they know virtually nothing and even say so, though not directly:

> "Windcatchers in medieval Cairo and Masdar City // 1. Medieval Cairo // Wind towers or windcatchers (*malqaf* in Arabic) capture the preferable, cooler, upper layer of air and force it to pass through the tower shaft,

414 Richmond, "The significance of Cairo" (1913), p. 40.

415 Hassan & Hyowon Lee & Uoosang Yoo, "From medieval Cairo to modern Masdar City: Lessons learned through a comparative study" (2015).

> supplying indoor spaces with cross-ventilation (Roaf 1990). Due to Islamic Cairo's tightly packed form, ancient Arab architects were forced to invent a technique to cool the courtyard. ..."

That's all they say about the wind-catchers of medieval Cairo. Now Susan Roaf, cited here, is an expert on wind-towers in Yazd – شهر بادگیرها, *shahr-i bādgīrhā*, "city of wind-towers". And the Cairo *malqaf*s were designed primarily to cool the living quarters below whether or not these were associated with courtyards.

Perusal of over one hundred recent studies on wind-towers in Iran (and the Gulf and Sind) reveals that not a single one of their authors have had any idea that there was also a 1,000-year tradition of wind-catchers in Cairo! In her 1990 paper "The traditional technological trap" cited by the three authors, Susan Roaf did not mention wind-catchers in medieval Egypt. How could she have? They were documented only in two orientalist studies that were not known in the world of the *bādgīr*s and were not known even in Egypt. Our three authors do not present a single illustration of a Cairo wind-catcher. Susan Roaf, on the other hand, was surprised and pleased to learn of the wind-catchers of medieval Cairo when I sent her a preliminary version of this monograph in August, 2019.[416]

Barely anyone cited by our three authors escapes their wrath, for they fall for all the bad things that orientalists are supposed to be. There is inevitably no mention of and no understanding of the very clear distinction between the "orientalists" who supposedly denigrated medieval Islamic civilization and the "orientalists" who documented it or published it. For our authors, orientalists are defined mainly in terms of colonialist interests.

The scholar who gets the most blame from our young urban planners is, of course, the British expert on the history of Islamic architecture, K. Archibald C. Creswell (1879-1974), fondly called "Archie" by his friends,

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[416] Note added in March, 2020: In her lecture "The amazing wind catchers of Yazd" at the Iran Heritage Foundation in London (iranheritage.org) on 04.03.2020, Susan Roaf did indeed mention the wind-catchers of Cairo.

who, at least in the opinion of the present writer, did more for the architectural heritage of medieval Cairo in the Anglophone world than all others put together. Our authors maintain:

> "Orientalists' allegations have contributed to a cheapened image of the conventional Arab city. Arab planners ignored their heritage, particularly in urban planning and architecture. Creswell misunderstood Arab society and urbanism. Most Arab planners dismissed Arab-Islamic architectural heritage and adopted Western planning theories that were applied to a very different social structure, in comparison to the habitat for which they were originally designed. The results were disappointing on all levels, notably that of urbanism."

Oy veh! The only publication of Creswell's in our author's bibliography was a 7-page specialist article for art connoisseurs published in 1953.[417] Entitled "Problems in Islamic architecture", it dealt scientifically and in plain English with various historical questions of some interest (only) to architecture historians. Creswell's article was not entitled "The problem with Islamic architecture". To claim that the author of those splendid volumes *Early Muslim architecture* and *Muslim architecture of Egypt* "misunderstood Arab society and urbanism" on the basis of that single specialist article (or any of his major publications) is outrageous. For Creswell the "problem" with Islamic architecture was that it needed to be documented scientifically, to which endeavour he devoted his life.

We shall return to these authors in **Ch. 16**, not because they write about the *qibla* in the planning of medieval Cairo or modern Masdar City, but because they do not.

Amenah Abdulkarim

I conclude this chapter with a 2017 doctoral thesis on the role of the master-builder / engineer / architect (*muhandis*) in Mamluk Egypt by

[417] Creswell, "Problems in Islamic architecture", *The Art Bulletin* 35 (1953): 1-7, available at https://vdocuments.mx/problems-in-islamic-architecture.html.

Amenah F. Abdulkarim, now of the University of Kuwait, who besides Jaubert 1995 and Masarwa 2017, is **the first scholar in over 30 years to really appreciate the importance of the *bādahanj* in medieval Cairene architectural history.**[418] Indeed, she devotes a section of some seven pages to summarizing in a most precise and scholarly fashion what I wrote in King 1984, and including several of the illustrations there.[419] What I find most surprising is that, in the various medieval sources on the *muhandis* and his duties and activities which Amenah Abdulkarim has gathered and analyzed, there is plenty of new information for architectural and social history, but apparently not a word about the construction of *bādahanj*es. What I find most pleasing about this dissertation is that with it the history of Islamic architecture progresses using the available textual sources, hitherto rather neglected in favour of the architectural and archaeological ones.

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418 Amenah F. Abdulkarim, *Building Craftsmen in Mamluk Society 648-943/1250-1517 – The professional muhandis in context*, PhD dissertation, Queen Mary University of London, 2017. See esp. pp. 55-61 and the accompanying figures from King 1984 on the construction of *bādahanj*es. This new work is based on an imposing number of original Mamluk sources on building construction, public decorum and daily life, as well as endowment deeds.

See also the same author's paper "The Mamluk Miʿmār: A new interpretation of endowment deeds and chronical narratives", of which I have seen only a summary.

419 It is a pity that the author did not contact me whilst writing her thesis. If she had, I could have pointed her to Rosenthal 1979 and Jaubert 1995, and the new version of King 1984 in *In Synchrony with the Heavens* (2004). In the latter, the mistaken identity of the anonymous author of the Dublin treatise is corrected from Ibn al-Sarrāj (Aleppo *ca*. 1325) to the contemporaneous Cairene scholar Najm al-Dīn al-Miṣrī. In Abdulkarim, p. 58, "Ibn Yūnus" is now identified as a non-existent Ayyubid astronomer (d. 1211), when he is, in fact, none other that the Fatimid astronomer Ibn Yūnus (d. 1009). Also, on p. 92, fig. 1.11, the caption is to be corrected: A is the Fatimid City and B is the City of the Dead.

Arabic-language websites

The webpages on the *malqaf* on the popular Arabic websites www.marefa.org/ملقف and ar.wikipedia.org/wiki/ملقف are singularly weak on historical issues. The latter includes a single image of a group of very sad Cairo *malqaf*s (**Pl. N11**), which is a sorry tribute to a 1,000-year tradition, as well as a plan of the splendid *qāʿa* of Muḥibb al-Dīn (1350) (**Pls. Q1-3**), presented as "Persian". This constitutes what the Egyptians call اي كلام . More serious is the fact that an organization such as INSIDEflows.org – "a platform for interior architecture based on knowledge of flow" – has nothing on the wind-catchers on Cairo, but also nothing on the wind-towers of Iran. At least they have heard of the former wind-sails of Hyderabad.[420]

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420 www.insideflows.org/project/ancient-wind-catchers-in-hyderabad/.

11 — More on the Cairo wind-catchers

The early history of the wind-catchers of medieval Cairo is still a matter of some speculation and cannot concern us here. There is evidence, not incontestable, that wind-catchers were featured in domestic architecture in Ancient Egypt. However, the medieval Cairo wind-catchers cannot represent a purely Egyptian development of the ancient Egyptian wind-catchers because of philological considerations: it is well-established that the medieval Egyptian name for wind-catchers was the Arabicized Persian word *bādahanj*. Several scholars have suggested that the medieval Egyptian wind-catchers were inspired by those used in Abbasid al-ʿIrāq. However, the sparse information available on medieval ʿIrāqī wind-catchers does not permit any comparison with the Cairene ones. This notwithstanding, it is of interest that one of the four kinds of Cairo wind-catchers was called *furātī*, a term derived from *al-Furāt*, the Euphrates.

What were they made of?

> "Les auvents des *malqaf*s sont très légèrement construits : en bois ou même en roseaux recouverts de plâtre aux deux faces. C'est pourquoi une grande quantité d'entre eux a disparu. D'autres ont été éliminés par suite de l'adjonction d'un étage au-dessus d'une *qāʿa* ou d'une *mandara*. Mais les grilles sus-mentionées, restées en place aux plafonds des salles permettent d'affirmer que **ce mode de ventilation était extrêmement répandu**." / "The scoops of the wind-catchers are very lightly constructed, in wood or even in reeds covered with plaster on both sides. This is why a large number of them have disappeared. Others have disappeared as the result of the addition of an additional storey above a *qāʿa* or a *mandara*. However, the grilles mentioned above that are still *in situ* in the ceilings of certain rooms enable us to affirm that **this method of ventilation was extremely widespread**." Alexandre Lézine, "La protection contre la chaleur dans l'architecture musulmane d'Égypte" (1971), p. 14 (my emphasis).

There is no mention in our medieval texts of the materials with which the Cairo wind-catchers were made. From the one on the 14th-century *Qāʿa* of Muḥibb al-Dīn, the oldest surviving example (**Pls. Q1-3**), we know that they might be made of stone (and could survive over half a millennium). From the 19th-century wood-cuts and paintings it seems they were mainly made of wood and were therefore short-lived and soon rendered redundant. Certainly the Musāfirkhāne *bādahanj* was a monumental wood construction. Wood was a commodity that was always of short supply in Egypt,[421] and I leave it to others to speculate how such a common architectural feature could be made of such an uncommon material. Monumental wooden doors and wooden ceilings and wooden *minbar*s and wooden *Qur'ān*-stands, these are another matter.[422]

The wind-catchers varied in size from the small installations consisting of a 'roof' of planks, such as we see in David Robert's paintings (**Pl. F2-5**), to enormous structures the same size as the entire top floor of the building they are mounted on, such as we see in the Musāfirkhāne Palace (**Pl. R1-3**) and in the Palace of Alfī Bey (**Pl. C9-10**). Even when the roof of a wind-catcher had collapsed, the wooden frame might be saved for eventual re-use (**Pl. D16**). The vast majority have therefore disappeared save for the shafts inside the edifices they once adorned. The Musāfirkhāne *bādahanj* represents an entire lost tradition of medieval green architecture.

Four different kinds of wind-catchers

Four different kinds of air-catchers are identified by Najm al-Dīn al-Miṣrī and confirmed half a century later by Ibn al-Qāṣiḥ –see **Ch. 19** – but the details are somewhat obscure:

"The *furātī* is the one which stands on the flat surface (*al-qā'im ʿalà saṭḥ*

[421] See the article "<u>Kh</u>a<u>sh</u>ab" by Claude Cahen in *Enc. Islam,* 2nd edn., and the references there cited.

[422] For details see Behrens-Abouseif, *Cairo of the Mamluks* (2007), pp. 95-97.

> *mustaqīm*). The *mujannaḥ* (literally, “winged”) is the one which stands on a surface, “winged” like the wings of a bird (*qā’im ʿalà satḥ mujannaḥ* [perhaps read *mujannaḥ*[an]] *ka-ajniḥat al-ṭayr*). The *killī* (that is, like a veil) is [read: has?] the sloping surface (*al-satḥ al-mā’il*). The *ʿādilī* is the one which is by the side of a wall (*yakūn bi-janb ḥā’iṭ*).”

It seems that all but two of the examples known to us from early woodcuts and paintings and photographs are of **the *furātī* variety**. But we have nothing similar from the Euphrates region with which to compare this majority.

An important example is to be identified in an anonymous photograph that was featured in the Egyptian exhibit at the Exposition Universelle in Paris, 1889 – **Pl. D20**. The top of the roof of the device is attached to the top of the wall overlooking the street. The roof slopes downwards about 20° over the street and is supported by symmetrical wooden struts. Perhaps this is a wind-catcher of **the *ʿādilī* variety**. The problem is: no window or orifice is clearly visible on the wall underneath the contraption. Now ʿĀdil is a personal name, with a meaning as in the adjective *ʿādil*, “just”. For the period in question we can find (1) the Fatimid *wazīr* al-ʿĀdil ibn al-Salār, a repugnant fellow assassinated in 1153; (2) the Ayyubid ruler al-Malik al-ʿĀdil, brother of Saladin, born *ca*. 1145 in Damascus or Baalbek, died outside Damascus in 1218; and (3) the latter’s grandson, also an Ayyubid ruler of Egypt, who died in prison in Cairo in 1248.[423] None of these is a candidate for the design of a variety of *bādahanj*.

More obvious is a wind-catcher of **the *mujannaḥ*, “winged” variety**, visible from the inner courtyard of the Palace of Ḥasan Kāshif – **Pl. C12**. On this the two parts of the roof, one on each side, each inclined to the roof at about 70°, meet each other at the top. The wind can enter through

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423 See the articles “al-ʿĀdil ibn al-Salār” by Gaston Wiet, and “al-Malik al-ʿĀdil, I-II” by H. A. R. Gibb in the *Enc. Islam*, 2nd edn.

a tall triangular space, surely open only on one side to the north and closed on the other.

I have no idea what **the *killī* variety** is.

At the bottom of the air-shaft of the wind-catcher there would be some kind of cover (طبق, *ṭabaq*) to avoid a gaping hole in the ceiling. The grilles over the bottom of the air-shaft below the (no-longer-extant) wind-catcher on the 15th-century Manzil al-Sādāt al-Wafā'iyya (Jaubert #40) in a recess in the south-east of the large *īwān* are still *in situ* – **Pl. Q4**.[424]

The western side of the wind-catcher should be open!

> "A *bādahanj* in which the air of east and west
> Flows according to the best manner and method –
> When the winds of the atmosphere come to it in disarray,
> They blow in it in no other way but an orderly one."
> The poet Burhān al-Dīn al-Qīrāṭī, Cairo, *ca*. 1350.

The early-14th-century Cairo astronomer, Najm al-Dīn al-Miṣrī, in a chapter on setting up the *bādahanj* – see **Ch. 19** – presents an ingenious and distinctive method to make the scoop of the device not only open to wind from the north-east, but also open to winds from the north-west:

> "When you have made the *maḥilla* of the *bādahanj* as I have described, draw a line from the east point to twice the rising amplitude of Capricorn and this will be the closed part (*al-mawḍiʿ al-masdūd*); then draw a line from the west point to twice the setting amplitude of Cancer and this will be the open part (*al-mawḍiʿ al-maftūḥ*). The total number of degrees on the (horizon) circle corresponding to the favourable winds is [183°] (text has: 153°) and the number of degrees on the circle corresponding to the unfavourable winds is 207°."

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[424] Raymond & Maury & Revault & Zakariya, *Palais et maisons du Caire, II: Époque ottomane (XVIᵉ-XVIIIᵉ siècles)* (1983), pl. 127.

This ingenious provision enables the wind-catchers to indeed catch all of the favourable winds of local folklore, and to block unfavourable winds from other directions. The Musāfirkhāne is/was the best example of this technique. Other surviving examples that have been renewed in recent years sometimes have both side sections filled in.

In the images presented in **Part II** the reader will observe numerous examples of wind-catchers open on the western side only. In some 19th-century paintings the artists have thought that both sides should be open or closed, or facing the artist regardless. Early photos on which both sides of a wind-catcher can be seen, show one side open.

Two distinct shapes for the medieval *bādahanj*es

We have seen above that two distinct shapes for the *bādahanj* are described in the medieval astronomical texts. The dimensions of the rectangular base proposed by Ibn Yūnus were 10 : $5^1/_2$. Note that the *bādahanj* on the Musāfirkhāne had a width equal to about one-half of its length! Those proposed by Najm al-Dīn al-Miṣrī were about 4 : 1 – see **Pls. S6-S7.** Clearly it would be of interest to investigate some of the earliest surviving examples to see whether any correspond to the medieval prescriptions.

Olivier Jaubert's typology of wind-catchers

Now Olivier Jaubert was particularly interested in the typology of the wind-catchers on which he had information.[425] The reader must consult his article for his conclusions. Here I list only the different types that he was able to record. They are quite different from the obscure typology of the medieval astronomical texts.

In brief, Jaubert defined two main types,

425 Jaubert, "Capteurs de vents", pp. 213-218.

1a a “catcher” partly constituting the ceiling of the room below;

1b a “catcher” fitted with a horizontal grille; the joists of the ceiling are not interrupted;

1c a “catcher” with a short external vertical duct and horizontal grille;

2a a “catcher” with a vertical masonry duct through successive storeys and an opening at the bottom of the wall at the side;

2b a “catcher” with a vertical masonry duct through successive storeys and with an opening in the ceilings.

The interested reader should consult Jaubert’s study for details and further information. Jaubert also categorizes each known example, where possible, and finds essentially that type 2a is predominant on Islamic buildings until *ca*. 1300, type 1c until *ca*. 1650, and type 1a from *ca*. 1775 to *ca*. 1850.

Jaubert assumes a direct link to Ancient Egyptian wind-catchers, and does not discuss the fact that over many centuries they were called by a Persian name, which he seldom mentions, obviously preferring *malqaf*. He does not discuss the orientation of the wind-catchers save to state that they are open to the northerly winds.

Modulating the air-flow in a *bādahanj* and closing it when necessary

Observations made by Olivier Jaubert on site in Cairo cast light upon the means of modulating the air-flow and closing a *bādahanj*, sometimes but not always using wooden shutters on the upper opening at roof level .[426] Likewise, some textual sources from the Geniza mention this.[427] Such a feature is an integral part of the device and serves to protect the occupants

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[426] Jaubert, “Capteurs de vents” (1995), #24, 48, 54, 67, 77.

[427] *Ibid*., p. 171, n. 12, & p. 175, §6.

of the building in winter and during bad weather. It is seldom if ever mentioned in any other modern sources.

Iranian colleagues on the Egyptian *malqaf*s

In a 2013 comparative study of wind-catcher types in the Islamic world, three Iranian scholars, Mohammad Bahramzadeh & Bahador Sadeghi & S. Sabok Rou,[428] quoting an earlier source published in Yazd which I have not been able to consult, have the following to say about wind-catchers in Egypt:

> "Wind catcher in Egypt. *Mokalaf* (which literally means the receiver of wind), has been used by the ancient Egyptians around 1300 years BC and has been one of the important factors in local architecture of Egypt for a long time. *Mokalaf* has been used for building of Egypt in hot and dry areas, and is an appropriate factor in natural ventilation. The use of large windows for natural light into the building is not suitable in these areas because it causes the entrance of the air and sand into the building. There are different samples of *Molaghaf* in Cairo houses. In a big house in Cairo, sometimes *Molaghaf* is placed on top of the summer staying part of the house which is connected its lower room due to its long chamber. In Cairo, there are also some *Mokalaf* related to the 19th century in which the openings (vents) are directly connected to the lower chamber by a hole in the roof. *Mokalaf* "Qaa" is one of the excellent samples which is one of the architectural works of Mohebodin shafiol Movakel [!] in Cairo which is built in the year 1350 AH [*sic*: read 1350!]. Wind catcher plans of Egypt are like rectangular which are placed over the flat roofs. An Egyptian *Molaghaf* includes a long column on top of a building and an opening into wind which is often located to the northwest winds. Roof angle is of 30 degrees which enables better penetration into the building."

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428 Bahramzadeh & Sadeghi & Rou, "A Comparative Study to Compare the Wind Catcher Types in the Architecture of Islamic Countries" (2013), p. 315, citing Mahmoudi, 2009, p. 18.

An important study of wind-catchers by an Iranian scholar who included a brief discussion of Egyptian ones is by Mohammad Amiri-Kordestani in a 2013 Master's thesis at the Université de Montréal.[429]

Modern studies by Iranian environmental engineers have revealed that the basic design of the Cairo wind-catchers (without consideration of the modifications to one side) may not have been inappropriate when compared with modern notions of ventilation in windy regions.[430]

What's in a name? *Was ist das*?

> "(Edward W.) Lane's transcription of Arabic words is nothing less than a nightmare. The reader encounters such monstrosities as Ruma'da'n, Ab'oo Ckeer, Rebee'a al Aou'wal, Shurckee'yeh, Ckusr El-'Ey'nee, Soolta'n Ckala-oo'n, Musr 'Ateeckah, Medee'net El-Cka'hireh and even Bur'ckoo'ckee'yeh! These forms are extremely irritating and a nuisance to the reader." István Ormos, "Lane's *Description of Egypt*" (2001), p. 224, cognizant of the fact that Lane just happens to also be the author of the best dictionary of Classical Arabic into English ever published):

The reader should be forewarned that in this section I offer only tidbits of information in no particular order. There are no conclusions of consequence, other than the obvious one: that the traditions of the *bādahanj* in al-ʿIrāq and Syria need further investigation.

The medieval Egyptian term for the wind-catchers was an Arabicized Persian word باذاهنج, *bā<u>dh</u>āhanj*, an uncommon alternative to the standard

429 Mohammad Amiri-Kordestani, "Natural air conditioning – traditions and trends: high performance of sustainable indoor ventilation in a hot and dry climate", (2013).

430 See Dehghani-sanij & Soltani & Raahemifar, "A new design of wind tower for passive ventilation in buildings to reduce energy consumption in windy regions" (2015).

Persian, medieval and modern, بادگیر, *bādgīr*. The Persian word, most correctly spelled *bā<u>dh</u>āhanj*, was apparently less common than *bādgīr* for a wind-catcher, and is derived from the noun باد, *bād*, "wind", and the verb آهنگیدن, *āhangīdan*, "to pull out or to extract". The *d* or <u>*dh*</u> of the Arabicized form would be pronounced as a *d* in Middle Arabic, and a vowel is required after this letter. The fact that a long *ā* vowel occurs in some of the astronomical sources indicates that the word was borrowed in its correct form *bādāhanj*. The medieval texts published by Rosenthal have *bādhanj* or *bādahanj*, those investigated by King have *bādahanj* or *bādāhanj* or *bā<u>dh</u>ahanj* or *bā<u>dh</u>āhanj*. This, therefore, is the term used in the medieval Egyptian literary and scientific literature, as well as the *waqfiyya*s, if not on the streets.

One of the few Arab linguists who discussed the word *bādahanj* was the Egyptian Shihāb al-Dīn al-Khafājī (1571-1659), encountered above, who claimed in his book on foreign loan-words in Arabic, that it was arabicized (معرب, *muʿarrab*) from بادخون, *bādkhūn* or بادگیر, *bādgīr*, which is not the case.[431]

My colleague Lutz Richter-Bernburg kindly gave the following linguistic explanation. The Arabic form with postvocalic spirantized *dāl* as well as the final *jīm* point to an "early" (*i.e.*, relatively early Islamic) borrowing from (late Middle-?) Persian since such spirantization subsequently disappeared from Persian and *gīm* became the affricate *jīm* perhaps sometime during the 9th century. Additionally, the "original" form was *bā<u>dh</u>āhang*, with the second long-vowel frequently shortened both in Persian and in Arabic. Unfortunately, we have found only one "really" early Arabic attestation (recorded by al-Masʿūdī), that is, from the time suggested here for the borrowing, and a few more from the 10th century.

Franz Rosenthal mentioned that in one of the manuscripts of al-Ghuzūlī's treatise (MS Istanbul Ahmet III A2627) there is a note to the effect that

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431 On al-Khafājī and this reference see n. 155 above.

the poet al-Qīrāṭī associated the numbers 2-1-4-5-50-3 with the letters *b-a-d-h-n-j* of the name. He surmised that this might be relevant to the complicated riddle that we still cannot fully explain – see above – but this does not seem to be the case.[432] These numerical equivalents to the alphanumerical letters indicate that the third letter is *d* = *dāl* rather than <u>dh</u> = *<u>dh</u>āl*, but the *<u>dh</u>āl* was frequently used in the astronomical sources. They also indicate a lack of a second long ā vowel, which may explain why Rosenthal used the name *bādhanj* in the title to his paper rather than the more correct باداهنج, *bādāhanj*, or at least بادهنج, *bādahanj*, – even more correct would be باذاهنج with ذ, *<u>dh</u>āl*, instead of د, *dāl*.

Alev Masarwa in her 2017 study of the newly-identified medieval Egyptian anthology of poetry by Ibn Abī Ḥajala uses throughout the term *bā<u>d</u>hanǧ*, the <u>*d*</u> standing for Arabic ذ, *dh*, and the *ǧ* for Arabic ج, *j*, which would be pronounced *g* by Egyptians.[433] Her orthography follows the standard German orientalist convention, which is precise but somewhat pedantic and has long been abandoned by others. (Also, the internet cannot handle it.) In all of the poems analyzed, the structures are called *bā–d/<u>dh</u>–a/ā–hanj*. Masarwa calls them "wind towers" following the Iranian usage, although the Egyptian wind-catchers are not towers.

The modern Arabic term *milqaf* (classical) or *malqaf* or *mal'af* (colloquial) which everybody nowadays applies to these devices is nothing other than modern,[434] and has entered into the modern literature instead of the word that was used over the centuries, namely, *bā<u>dh</u>ahanj*. The word has

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432 Rosenthal, "Poetry and architecture", p. 7. On the Arabic *abjad* notation see nn. 521 and 789.

433 Masarwa, "Urban architecture and poetry: Two medieval Arabic anthologies as manuals of mapping urban space" (2017), *passim*.

434 On *malqaf* in modern Egyptian Arabic see Badawi & Hinds, *Dictionary of Egyptian Arabic*, p. 796: "1. a device built on a roof for catching the breeze and conducting it to the rooms below (specifically, in old houses, a large wooden shed with a sloping roof open to the north). 2. *malqaf hawa* draught of air. ... "

undergone abominable distortions in many recent publications – see below. Even Egyptians are no longer totally happy with the word *malqaf*, literally "catcher": there is an increasing tendency (as in the thesis of Lamees al-Dasouqi) to prefer the construct *malqaf al-hawā'*, "catcher of the wind". When searching for images of these devices on the internet I found it useful to google with the various medieval and modern names.

The "orientalist" dictionaries are also of interest. For example, the British orientalist of German Jewish descent, Francis Joseph Steingass (1825-1903), in his 1892 *Persian-English Dictionary*[435] listed:

> "*bid-hinj*, *bad-hanj*, a contrivance on the top of houses in the East, in the form of a chimney, having an opening face to the west, which, catching the breeze, gives a refreshing coolness to the apartments with which it communicates."
>
> "*bid-gi*, *bidgir* as "an airy house; a funnel perforated in every part for the admission of air."

The Dutch orientalist of French origin, Reinhart Dozy (1820-1883), in his *Supplément aux dictionnaires arabes*,[436] lists *bādahanj* and also a contracted form *bādanj*. To him it meant

> "tuyau semblable à celui d'une cheminée servant de ventilateur" / "a pipe similar to that of a chimney and serving as a ventilator",

He is citing Ibn Baṭṭūṭa, the *1001 Nights*, and also lists an unidentifiable source – "Macn. I, 201" – where he found the expression بادهنج الى جانب المطبخ, *bādahanj ilà jānib al-maṭbakh*, "a wind-catcher toward the side of the kitchen".

The French orientalist Régis Blachère (1900-1973) and his co-authors in their *Dictionnaire arabe-français-anglais* (1967) list بادنج, *bādinj* and بادنجان, *bādinjān*, quoting Ibn Baṭṭūṭa and Dozy.

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435 Steingass, *Persian-English Dictionary* (1982), pp. 140b and 140a.

436 Dozy, *Supplément aux dictionnaires arabes* (1881), I, 47b.

Muhammad Amin & Laila Ibrahim, in their 1990 book *Architectural terms in Mamluk documents* (in Arabic) list بادهنج, *bādahanj*, as:[437]

> "Arabic borrowed from the Persian: celui qui aspire le vent / something that breathes in the wind",

although Ibrahim otherwise overlooked wind-catchers in her writings on historical Cairene domestic architecture.

The Egyptian historian of Islamic architecture Mona Zakariya redefines *bādāhanj* from the point of view of the *waqf*s simply as an opening in the ceiling of a side-chamber of an *īwān*.[438]

In my 1973 study of the Cairo corpus of tables for timekeeping and regulating the times of prayer I unfortunately used the word "ventilator" for *bādahanj*. I think that I followed Zand *et al*. in their translation of ʿAbd al-Laṭīf al-Baghdādī. Franz Rosenthal in 1977 used the expression "air-shaft" for wind-catcher, possibly because he was influenced by the story of a corpse being lowered down the shaft of a *bādhanj*. Again in 1984 I used the word "ventilator" in my paper on the Cairo wind-catchers.[439] Jaubert used more appropriately "capteur de vents". The fact that we did not use "wind-catchers" is one reason why only Iranian wind-catchers now predominate on the internet, even on *Wikipedia*, and the Cairene ones are almost omitted entirely and have fallen into obscurity.

In the *Wikipedia* article "Windcatchers", dominated by the situation in Iran, someone has inserted a short section on wind-catchers in Egypt, two

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437 Amin & Ibrahim, *Architectural terms in Mamluk documents* (in Arabic), p. 19, cited in Jaubert, "Capteurs de vents", p. 19.

438 Zakariya, *Deux palais du Caire médiéval – waqfs et architecture* (1983), I, line 42, and II, line 55, and the glossary.

439 Googling the words "Cairo ventilator / ventilation" yields primarily Dr. J. M. Cairo's latest editions of the book by Susan P. Pilbeam (b. 1945) entitled *Mechanical Ventilation: Physiological and Clinical Applications*. There is also the German home decoration company cairo.de which sells 'Tischventilatoren'.

sentences on Ancient Egypt, and one sentence on the name of wind-catchers in Arabic:

> "Windcatchers were used in traditional ancient Egyptian architecture. A painting depicting such a device has been found at the Pharaonic house of Neb-Ammun, Egypt, which dates from the 19th Dynasty, c. 1300 BC. In Egypt the windcatchers are known as *malqaf* pl. *malaaqef*."

بس كدا ! . That's all!

C. Edmund Bosworth's article "Bādgīr" in the 1980 supplement to the *Encyclopaedia of Islam* was inevitably concerned mainly with the Iranian tradition, but at least mentions Franz Rosenthal's study, the astronomer Ibn Yūnus, and one Cairo wind-catcher (actually the one at the Mosque of the Fatimid *wazīr* al-Ṣāliḥ Ṭalā'iʿ, 1160 – Jaubert #17). The article "Bādgīr" by Susan Roaf in the *Encyclopædia Iranica* (1988) does not mention the Egyptian tradition at all. Why should it, or how could it? There is an article "Mas̲h̲rabiyya" by Doris Behrens-Abouseif in the authoritative second edition of the *Encyclopaedia of Islam* but no article "Milḳaf".

The reasons why a Persian term was used in medieval Egypt have been briefly and not conclusively discussed by Rosenthal and his former student.[440] An interesting question is whether the term *bādahanj* was used in medieval Iran. We do not know that there were wind-catchers in Iran when they appear in Cairo in the 10th and 11th century with a Persian name. When the prominent Iranian linguist ʿAlī-Akbar Dehkhoda (1879-1956) in his monumental Persian dictionary *Lughāt-nāme* cites the Maghribī traveller Ibn Baṭṭūṭa and the Egyptian poet Burhān al-Dīn al-Qīrāṭī and also the orientalist Dozy in his entry for *bādahanj* (written بادهنج) but **no Persian sources**,[441] we can be fairly sure that this word was

440 Rosenthal, "Poetry and architecture" (1978), pp. 4-5; and King, "Architecture and astronomy" (1984), pp. 101-103 / *Synchrony*, VIIb: 787-788.

441 Dehkhodā, *Lughāt-nāme*, 31/1 (ب - بابك), p. 260.

not used in medieval Iran. The modern Persian name for the devices which have been known in Iran for at least 500 years is *bādgīr*, and that's that!

Meanwhile, the fact that باداهنگ, *Badahang*, is to this day a common Iranian family-name (just google it!). This is rather strong evidence that the word was current in Iran in earlier times.

The term *bādahanj* is also attested in one medieval Egyptian source – al-Qalqashandī's encyclopaedia from *ca.* 1400 – with the meaning of "a fashionable garment with wide openings in the sleeves":[442]

> وقد ذكر في مسالك الابصار ان اكابرهم كانوا يجعلون في اكمامهم بادهنجات مفتوحة وقد صار ذلك الان قاصرا على ما يلبسونه من التشاريف ...
>
> "In the book entitled *Masālik al-abṣār* (of Ibn Faḍlallāh) it is stated that the older people among them used to make large open vents (*bādahanjāt*) in the sleeves of their gowns but this custom is now restricted to the clothes they wear on ceremonial occasions."

When the term *milqaf* as an architectural feature occurs in a medieval text it does not necessarily apply to a wind-catcher.[443] The term *milqaf* in the *Arabian Nights* has a meaning different from wind-catcher – see **Ch. 4**.[444]

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442 al-Qalqashandī, *Ṣubḥ al-aʿshà*, IV, p. 43, cited in King, "Architecture and astronomy", pp. 119-120 / *Synchrony*, VIIb: 788. See also n. 209 above. The term is not listed in Dozy, *Dictionnaire détaillé des noms des vêtements chez les Arabes* (1845).

443 Rosenthal, "Poetry and architecture", p. 2; King, "Architecture and astronomy", p. 103 / *Synchrony*, VIIb: 787-788.

444 *Arabian Nights*, ed. Macnaghten, (Calcutta 1839-42), II, 104:

> ثم سحب سيفه في يمينه واخذ ملقفه في يساره واقبل على قاعة الجلوس التي للخليفة ونصب سلم التسليك ورمى ملقفه على قاعة الجلوس فتعلق بها وطلع على السلم الى السطوح ورفع طابق القاعة ونزل فيها فوجد الطواشية نائمين فبنجهم واخذ بدلة الخليفة والسبحة والنمشة والمناديل والخاتم والمصباح الذي بالجواهر ثم نزل من الموضع الذي طلع منه ...

What *milqaf* does mean here is open to discussion but it seems to be something like a fisherman's catch-all net. The anecdote relates someone armed with a sword and

In the *waqfiyya* of the Madrasa of Sultan Barqūq (1384-86) there is a curious reference to a *malqaf* with four square doors – see the end of **Ch. 4**. This has most probably nothing to to with a typical *bādahanj*.

Some Egyptian scholars who are not Arabists have problems with the Arabic word ملقف, *malqaf*, plural ملاقف, *malāqif*. In Egyptian Arabic the letter *q* is replaced by a glottal stop. Furthermore, modern Iranian renderings of these words leave much to be desired. The reader should not be surprised to encounter such absurdities as *mlaaqaf* in Egyptian theses and *molaghaf* and *mokalaf* in Iranian studies. You can even find stuff on the internet by googling *mulguf*. However, as we saw at the beginning of this section, some of the greatest Arabists have also had problems with transliteration of Arabic, Persian and Turkish words.

Various false etymologies of بادهنج , *bādahanj*, and even of ملقف, *malqaf*, and are circulating in certain modern Arabic sources, as, for example:

> والملقف يعني لغويا الباذاهنج وهو مصطلح فارسي معرب بمعنى منبسط او مفتوح والاخر هنج بمعنى سحب او جر ...

Oy veh! It is better not to say where I found this.

The Cairo-based Islamic Art Network at the Thesaurus Islamicus Foundation[445] has these two items in its glossary of architectural terms:

"**Badhahanj**: Derives from Persian, meaning 'opening for breeze' [*sic*]. An early form of air-conditioning [!], often found in medieval Cairene

such a *milqaf* netted the caliph's apparel down to his jewels. He then climbed a ladder (*sullam*) towards the roof of the reception hall and lifting open the cover (*ṭabaq*) on a hole in the ceiling of the hall, he entered into the hole and found the eunuchs asleep there. Maybe this was too much for him, so he came back down. Alas, the raconteur does not specifically say the eunuchs were asleep in the duct of a *bādahanj*, but they would not have been the only ones ever to have done that – see the tale of al-Tanūkhī in **Ch. 4**.

445 www.islamic-art.org/Glossary/.

houses, where a directional opening allowed cooler air to circulate and admitted light into the room.

Malkaf: A cooling and ventilation device composed of a wind scoop on a roof connected to a wind shaft. This creates wind circulation in the building."

The editors will surely be surprised that the two terms refer to precisely the same object.

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Finally, this topic calls to mind the French word *vasista*, also used in Spanish and Italian, which in the form *wass-ist-dass* was apparently introduced into French as *vasista* before 1776, and accepted as such by the Académie française in 1798. This provokes the image of a German-speaker posing the question "Was ist das?" / "What's that?", when looking at a small window at the top of a door.[446] In the *Annales d'hygiène publique et de médecine légale* of 1830, it is recommended to use *vasista*s to freshen the air in autopsy rooms. Later, *vasistas* are recommended for rooms for preparing butter and cheese, and for toilets and reducing temperature in theatres. Enough of a digression!

More on a possible Iraqi or a Syrian connection?

The Egyptian astronomical texts describe four different kinds of wind-catchers each with an individual name, one of which is فراتي, *furātī*, indicating that it was from al-ʿIrāq, through which flows the Euphrates, Arabic الفرات, *al-Furāt*. I have had no success searching for clear

[446] See "Vasistas" on en.wiktionary.org, and https://fr.wikipedia.org/wi—*—ki/Vasistas, and www.century21.fr/edito/article/quelle-est-lorigine-et-la-significati––*—on-du-mot-vasistas/ ("mot barbare"). It is a pleasure to thank Gesine Yildiz for introducing me to the word 'vasistas', to which I inevitably responded "Was ist das?". For the Russian windows of this kind see https://en.wikipedia.org/wi—*—ki/Fortochka.

statements about wind-catchers in medieval al-ʿIrāq. The Iraqi architect Subhi Al-Azzawi kindly sent me his doctoral dissertation and articles on early 20th-century ventilation schemes on houses in Baghdad.[447] A 2015 technical study of ventilators in Mosul mentions no historical examples.[448] Even the renowned British historian of Islamic civilization C. Edmund Bosworth was unable to point to any reference to any historical ʿIrāqī wind-catchers, although these would be an obvious link between Iran and Egypt.[449] On the brighter side, we can be grateful to the German scholar Felix Langenegger (dates uncertain), who was the official architect for Saxony, a former member of the German excavation expeditions to Babylon and Jericho, and technical leader of the excavations at very important Hittite and Aramaean site of Tell Halaf in Mesopotamia. His 1911 doctoral dissertation dealt with building techniques in Iraq. With remarkable thoroughness he documented numerous forms of *bādgīr*s in Baghdad – **Pl. P3a**.[450] Creswell noted the term *bājir* as the form of *bādgīr* used in Iraq**.** This term, which I have not seen in any medieval written source, should be investigated further in light of the fact that the Cairo wind-catchers may have an ʿIrāqī origin. One should not forget that Creswell was unaware of the name *bādahanj* which had been used for centuries in Cairo, only to be forgotten by the 20th century.

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447 For Iraq see Al-Azzawi, "Oriental houses in Iraq" (1969), *A descriptive, analytical and comparative study of traditional courtyard houses in Baghdad* (Ph.D. thesis) (1984), and "The courtyards of Oriental houses in Baghdad, non-functional aspects" (1986).

448 Khedher & Hussein, "Simulation for the buildings ventilation using windcatchers in Mosul" (2015) (in Arabic), with a rich bibliography but nothing on actual or historical wind-catchers in al-ʿIrāq.

449 Article "Bādgīr" in *Enc. Islam*, 2nd edn., suppl. vol.

450 Langenegger, *Beiträge zur Kenntnis der Baukunst des Iraq* (1911), esp. p. 180, also in Azzawi, *Traditional courtyard houses in Baghdad* (1984), p. 230. See also the Langenegger's *Durch verlorene Lande – Von Bagdad nach Damaskus* (1911, repr. 2015). I am grateful to Dr. Subhi Azzawi for this reference.

We have already mentioned the occurrence of the word *bādahanj* in the Arabic commentary on the *Book of Amos* by the 10th-century Karaite Jewish scholar Yephet ben Alī of Basra, later Jerusalem.[451] The relevant phrase found there is:

> بعضها بيوت الصيف وهي بادهنجات, *baʿḍuhā buyūt al-ṣayf wa-hiya bādahanjāt*, some of (these houses) are summer-houses, which are ***bādahanj*es**, …"

and it needs further investigation. There is no evidence that Yephet visited Cairo.

The *wazīr* and right-hand man of the Ayyubid ruler Ṣalāḥ al-Dīn al-Ayyūbī known as Saladin, al-Qāḍī al-Fāḍil (1135-1200),[452] was a fervent poet and was mentioned by the 14th-century anthologist al-Ghuzūlī (**Ch. 5**) as the most passionate of people about *bādahanj*es. It was said that the earliest poetry he cited was by Mihyār al-Daylamī (d. 1037)[453] who described in a poem the wind drawn from a *bādahanj* that he had constructed on the roof of his house, open on both sides toward the south and the north. Apparently he was writing about a house in Baghdad, for he moved there before his conversion to Islam from Zoroastrianism in 1003.

> وكان القاضي الفاضل وزير صلاح الدين الأيوبي أكثر الناس ولوعا بالبادهنج وله فيه أشعار واقوال وأقدم من ذكره من الشعراء مهيار الديلمي يقول في قصيدة يصف فبها هواء بيت مجلوب من بادهنج قد شيد على سطحه مفتوح الجناحين لمهب الجنوب والشمال

> "al-Qāḍī al-Fāḍil (1135-1200), *wazīr* of Ṣalāḥ al-Dīn al-Ayyūbī, the most passionate of people about *bādahanj*es, had (many) verses and statements about them. The earliest poet whom he mentioned was Mihyār al-Daylamī, who described in an ode the air in a house drawn from a *bādahanj* which he had constructed on his roof and which was open on both sides toward

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451 See n. 57 above.

452 Article "al-Ḳāḍī al-Fāḍil" in *Enc. Islam*, 2nd edn., by Carl Brockelmann and Claude Cahen. See n. 207 above.

453 Sezgin, *Geschichte des arabischen Schrifttums*, III (1975), pp. 566-567.

the sources of the south and the north winds.”

I have found no other references to a *bādahanj* being open in two opposite directions.

In the next section I shall discuss Creswell’s assertion of the existence of a *malqaf* in Syria – on the roof of the Ẓāhiriyya Madrasa in Aleppo – that would be older than all the few Egyptian ones he documented. This function has been accepted by several other writers, but, as we shall see, there are obvious problems with this claim.

A statement in a book by Muḥammad ibn Muḥammad al-Bahūtī al-Khalwatī (d. 1677), a commentary on the *Muntahā al-irādāt*, reads as follows:[454]

> الباذهنج: نافذة يجلب بواسطتها الهواء من السطوح إلى السراديب وغيرها، وتستعمل كثيرًا في العراق، وتسمى الآن: بادكير

> “The *bādahanj*: an aperture / opening by which air is drawn from the roofs into the water reservoirs or whatever below. It is much used in al-ʿIrāq, and it is now called *bādgīr*.”

In a 2013 comparative study of wind-catcher types in the Islamic world, three Iranian scholars, Mohammad Bahramzadeh & Bahador Sadeghi & S. Sabok Rou, quoting earlier Iranian colleagues, state the following about wind-catchers in Iraq:[455]

> “Wind catcher in Iraq. In Iraq, wind catchers are simply a hole in the thick mud brick or adobe walls on the roof for the summer living rooms and are built to the northwest in order to take the prevailing air and make the air cooler. Vertical pillars which are placed in these walls are the connecting

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454 The reference is to al-Khalwatī’s commentary at III, p. 583, and there is a further reference to a marginal commentary to a *Ghāyat al-muntahā*, II, p. 353. I have not pursued these. My thanks to Alev Masarwa for this and several other references.

455 Bahramzadeh & Sadeghi & Rou, “A Comparative study to compare the wind catcher types in the architecture of Islamic countries” (2013), p. 315.

openings (fans) of the roof with the basement (Bahadori & Dehghani, 2008, p. 268). Wind catchers in Iraq are very similar to Cairo *Mokalaf*. Some are designed in one-way rectangular plan. Wind catchers have a rectangular plan shape in Iraq. The width of wind catcher pillar is between 15 and 60 cm. Wind catcher channels do not rise far above the roof and wind catcher vents begin from floor level and do not go higher than about 0.5 m to 1.20 meters. The difference between them is that the channel roof is made of 45 degree curved shape while the roof of *Mokalaf* is not curved. Iraqi wind catcher place is generally on the edge of the roof and service their basement space (Mahmoodi, 2009, p. 20). Pillars are often terminated in inside shells of basement walls. The hot and humid wind that comes into the wind catcher flows in a variety of indoor space, and goes out from openings which are like open metal, small windows in basement which are located into the yard (Bahadori & Dehghani, 2008, p. 262)."

It is clear that this information cannot be relied upon, least of all in any historical investigation. The authors then present an illustration of types of wind-catchers in Iraq, taken from the 1988 dissertation of Susan Roaf. As far as Syria is concerned, we have noted that the 10th-century geographer al-Muqaddasī wrote that the Egyptians have *bādahanj*es like the Syrians do. I am unsure how to interpret this. Olivier Jaubert has collected some references in the modern literature to historical Syrian house-ventilation.[456]

I have checked some books by Freya Madeline Stark (1893-1993), the observant traveller of Anglo-Italian origin, who wrote of her impressions between Beirut and Afghanistan, but to no avail. It is beyond the scope of the present study to discuss the few references in the modern literature to wind-catchers in Iraq and Syria.

Yet many modern writers mention the *malqaf*s of Aleppo as if they were well-known. In a recent serious study of the reconstruction of Aleppo's

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456 See Jaubert, "Capteurs de vents" (1995), p. 190, n. 53, and p. 199, n. 55.

historic centre by Esref Gokalp and Fuat Uguz, submitted to the Politecnico Milano 1863, had the following to say about *malqaf*s:[457]

> "Al Malqaf was an innovative bioclimatic architectural element in the traditional residential buildings, which consist of shaft high rising above the building and opened from the prevailing wind side, constructed on the north side of the building to capture the cool air and channels it down into the interior of the building. This air flow concept can be applied to all the residential building types in various forms, based on the different climatic factors like humidity, prevailing wind flow, patterns and building materials. In the case of the old city of Aleppo, a special type of Al Malqaf was utilized, where all traditional building had one shaft located at the north side of the building to capture the cool air. Within the shaft water-filled jars were placed, to increase the internal climate's moisture, in this way the fresh air loaded with water vapor at summer time, could access by using operable windows. On the other hand, one of the effective bioclimatic elements in the traditional buildings of Aleppo was the indirect entrance, which clearly enhanced the privacy and air movement control. The entrance consists of double doors, the first usually led to a passageway and the second led to the courtyard. This design solution could reduce the heat transfer through the entrance in both hot and cold seasons, and improve air circulation inside the building through creating different air pressure between the passageway and the courtyard."

A solitary double *bādahanj* in Aleppo (?)

There are apparently no other serious textual claims about the existence of *bādahanj*es in Aleppo than the remark of Ibn Buṭlān (**Ch. 4**). However, there is one building in Aleppo for which a series of historians of Islamic architecture have claimed that it sports a *malqaf*, actually two. This is the Ẓāhiriyya Madrasa, completed in 1219/20. On the roof, almost directly

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[457] Gokalp & Uguz, "The reconstruction of Aleppo's historic centre" (n.d. [2018]), esp. p. 69, alas without any illustrations of an Aleppo *malqaf*.

behind a substantial dome, there is what looks like a doorway without doorstep, now two doorways after restoration – see **Pl. P6**.

Creswell was apparently the first to claim that the madrasa had a *malqaf* made of stone on the roof, and that it was earlier than the Cairene ones he was documenting. His photographs, published in his earlier paper, "Origin of the cruciform plan of Cairene madrasas" (1922), show that this looks more like a gaping door-frame with a roofed stair-case descending behind it.[458]

Michael Meinecke does not mention these features in his overview of Mamluk architecture.[459] His plan of the madrasa shows it facing almost due south.

(Since the orientations of Islamic religious architecture in Syria and Palestine has never been seriously investigated, let alone the orientations compared with the information in medieval lists of *qibla*s, the field is open to cranks who discover that this architecture is not facing the modern direction of Mecca – are we surprised? – and who seek to interpret this in total ignorance of medieval Muslim practice.)

One of the leading experts on Islamic architecture in Syria, Yasser Tabbaa, had the following to say in 1997:[460]

> "The south-eastern corner is occupied by a mausoleum whose dome is pierced by a *malqaf* (wind catcher), a rare sight in Aleppo."

Rare indeed.

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458 Creswell, "Origin of the cruciform plan of Cairene madrasas" (1922), pp. 6 & 16 and pls. IIIA & IVA, and *Muslim Architecture of Egypt*, I (1952), p. 285, n. 1, also II, pp. 81-82.

459 Meinecke, *Die Mamlukische Architektur in Ägypten und Syrien* (1992), I, p. 54, also II, p. 477a.

460 Tabbaa, *Constructions of power and piety in medieval Aleppo* (1997), p. 142.

The historian of Islamic architecture, especially that in Syria, Terry Allen, in a detailed description of the Madrasa in his book on Ayyubid architecture published in 2003 writes as follows:[461]

> "Prayer Hall and Tomb: The courtyard facade of the prayer hall is well preserved, except that the cornice is recent and the large openings have been filled with masonry. ... ... The prayer hall has a large central dome on split pendentives, flanked by two miter-vaulted bays matching the two smaller openings in the prayer hall facade**. Paired cupboards or air shafts are centered in the qibla wall in each side bay. The mihrab is set back into a large recess that corresponds to the wide frontal arch of the center bay.** The cross plan thus created is most unusual and, as Herzfeld noted, rather striking when experienced in person."

However, he also writes of "domes and rooftop staircases",[462] which makes much more sense, except for the question why there should be two identical ones? Nevertheless, the two openings on the roof apparently do lead to ducts which descend to apertures on either side of a *miḥrāb*. The openings themselves are partly blocked by the dome in front of them which will surely deflect some of the wind. The view on the left is toward the south, that is, roughly towards the *qibla* for Aleppo. The *qibla* in Aleppo in Mamluk texts is about 18° E of S.[463] This means that the *malqaf*s are open toward the west, but easterly winds predominate only in winter (November – January) and are bitterly cold at that. For most of the rest of the year (March – October) it is the westerly winds which predominate.[464] Thus these so-called "*malqaf*s" are quite useless for the purpose of

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461 Terry Allen, *Ayyubid Architecture* (1999), with the Ẓāhiriyya Madrasa at www.sonic.net/~tallen/palmtree/ayyarch/ch8.htm#alep.mzah.

462 www.sonic.net/~tallen/palmtree/ayyarch/ch8.htm#alep.mshar.

463 King, "A geographical table from 14th-century Damascus with *qibla*-values for localities in Mamluk domains (Syria & Palestine)" (2019).

464 www.windfinder.com/windstatistics/aleppo.

collecting favourable winds. It also means that the *miḥrāb* beneath the two would-be *malqaf*s will be facing perpendicular to the *qibla*.

The existence of these features raises questions that cannot yet be answered, and their positioning and orientation raises even more questions.

When is a hole in the wall an air-vent?

> "In many cases these structures have been ruined, and only their ground plans, or the lower parts of the fortifications, have been preserved. In two of them, however, the structures have been preserved to wall-head level. Kharana, east of Amman, is usually interpreted as a caravanserai. There are many puzzling things about this building, particularly the use of Sasanian-style rubble masonry covered with plaster rather than the ashlar [large square-cut stones as facing on walls of brick or stone rubble] more typically associated with Syrian building. The edifice presents a formidable face to the outside world. There are no windows, only slits, and one small door. There are towers on each of these sides, all of which are solid. There are no signs, however, of more specifically military features: there are no surviving battlements, no chamber in the towers and no machicolations and, from their position high above the floor levels, it is more likely that the slits are for ventilation than for archery. (We now turn to another such site.) Qaṣr al-Ḥayr al-Sharqī, to the north-east of Palmyra, is a complex site ... ." Hugh N. Kennedy, *The Armies of the Caliphs* (2001), pp. 187-188

We may be forgiven in suspecting that some architecture historians may have been confused into suspecting the existence of a ventilation system upon noting a slit in a wall which actually might primarily have served for archers or for pouring hot oil over unwelcome visitors, or a hole at the edge or corner of the ceiling of a room which actually belonged to a

chimney.[465] Clearly, as did the distinguished historian of the Near East, Hugh Kennedy, one should consider the entire complex to establish a primary military or guest-house status. In the case of Qaṣr Kharāna, there was controversy about its function and purpose, not least because the Arabic name *qaṣr* indicates a castle.

Here we need to state what we mean by ventilation system. A slit in a wall serves to admit air but does not ventilate. A wind-receptacle, little more than a slit, in an upper wall serving a duct which distributes air into the rooms below is what we have seen in recent Iraqi houses. The ventilation facilities in Cairene architecture are more clearly defined, distinguished by the scoop on the roof and a substantial air-duct, and, if properly understood, they invite less confusion. These different possibilities should be kept in mind for Syrian architecture.

Several colleagues have written about orifices in the ceilings of historical Syrian buildings as parts of ventilation schemes without investigating where the air might have come from. In the case of Shawbak there is no longer any roof anyway. And existing traces of ventilation shafts should be investigated in terms of their orientation with respect to favourable winds in the location where the building is situated. Since this has not happened even for Cairo, it is hardly surprising that it has not happened for Syria. In the one case where a "wind-catcher" survives on a historical Syrian building, it turns out to be aligned so that it catches the bitterly cold winter winds.

Qalʿat Najm on the Euphrates

The site of the fortifications of Qalʿat Najm near Manbij was strategic in the Roman and early Islamic periods because it overlooked a narrows on the Euphrates that was used as a crossing point on the route from Aleppo

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465 (In my house in rural France there were, until I had them surgically sealed, holes above each window in the *magnanerie*, which had originally served a serious purpose in silk production, as well as wetting the walls when it rained.)

to Harran, thus linking north-western Syria with northern Mesopotamia.[466] The site was refortified in the early 13th century. Cyril Yovitchitch, in his detailed study of Qalʿat Najm,[467] writes:

> “Surélevé par rapport aux autres espaces, le grand *īwān* communique avec deux petites pièces latérales ouvertes dans ses flancs. La pièce sud-ouest, couverte par une voûte d’arêtes, est pourvue d’une large ouverture que l’on pourrait interpréter comme une bouche d’aération destinée à générer un appel d’air pour ventiler les lieux, un capteur de vents (*bādhāhanj*) assurant ainsi une climatisation naturelle (Jaubert 1995).” / “Raised with respect to the other spaces, the large main *īwān* opens onto two small rooms, one on each side. The south-western room covered by a ridged vault has a large opening that could be interpreted as the bottom of a device for letting in air in order the ventilate the space below, a wind-catcher (*bādhāhanj*) assuring natural acclimatisation (as described in Jaubert 1995).”

What is interesting here is not only the information about the potential ventilation outlet, but the fact that the author is aware of the formal medieval Arabic form of the Egyptian devices, which is not used the reevant literature he cites.

The Ayyubid Palace in the Castle of Shawbak

The Italian historian of Islamic art and architecture has Martina Rugiadi has recently published a detailed description of the Palace within of the Ayyubid Palace of Shawbak in S. Jordan, which part dates from the first half of the 13th century.[468] The author identifies a ventilation system,

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466 Article “Ḳalʿat Nad̲j̲m” by Dominique Sourdel in *Enc. Islam*, 2nd edn.; also https://archnet.org/sites/17022.

467 Yovitchitch, “Qalʿat Najm. Forteresse-palais des bords de l’Euphrate” (2011), p. 124.

468 Martina Rugiadi, “Il complesso di ricevimento del palazzo ayyubide a Shawbak” (2012): 201-225, at www.academia.edu/3312632/. The citation is

which she describes in a sentence, but she uses the occasion to present a detailed and systematic account of the ventilation systems known to her in historical Syrian architecture, the first such survey of its kind. She is aware of the (independent) medieval Egyptian tradition but for Cairo her sole sources are two studies by Lézine 1972a/b, rather than King 1984 and Jaubert 1995. She not unreasonably links the two traditions for the Ayyubid period which is her primary concern, although, in fact, the Syrian and Egyptian traditions are independent. Rugiadi writes the following (asteriscs indicate the presence of frequent and well-documented references mainly to the authoritative works of Yasser Tabbaa and Terry Allen):

> "*Le nicchie e il sistema di ventilazione. ... ...* Le intercapedini verticali presenti sul retro delle nicchie nell'ambiente UF1 a Shawbak, con la funzione di elementi per la ventilazione e lo scambio di aria calda/fredda, sembrano essere state molto diffuse negli edifici ayyubidi.* Il loro impiego ha infatti una lunga tradizione nell'architettura residenziale islamica e preislamica:* denominati "cattura vento" (arabo *malqaf* o *milqaf*, persiano *bād-hanǧ*, *bād-henǧ*, *bād-gīr*), nel periodo ayyubide erano un elemento comune nella maggior parte delle case egiziane,* e sono attestati in alcuni edifici, anche religiosi, sia egiziani sia siriani. Possiamo citare gli ambienti di ricevimento nella cittadella di Aleppo (corte maggiore) e a Qal'at Naǧm;* ad Aleppo le *madrasa* al-Firdaws,* al-Sulṭāniyya,* al-Šarafīyya,* e a Damasco il Bīmāristān al-Qaymarī.* Mentre gli esempi siriani sono del tipo rinvenuto a Shawbak,* al Cairo, invece, gli elementi per la ventilazione che si trovano nelle *madrasa* o nelle moschee sono di tipologia diversa.* ʿAbd al-Laṭīf al-Baġdādī, che visitò il Cairo intorno al 1200, descrisse l'abilità con cui queste strutture erano costruite, i costi, che potevano arrivare a cifre consistenti, e l'esposizione sempre a settentrione.*" / "*The niches and the ventilation system*. ... . The vertical interstices found on the back of the niches in the principal reception area

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from pp. 132-134.

at Shawbak, which serve as elements for ventilation and switching hot and cold air, seem to be very common in Ayyubid buildings. Their use has indeed a long tradition in the residential architecture, pre-Islamic and Islamic:* **called "wind-catchers"** (Arabic *malqaf* or *milqaf*, Persian *bād-hanj*, *bād-henj*, *bād-gīr*), **in the Ayyubid period they were a common element in most Egyptian houses**,* and these are attested in several buildings, including religious ones, be they Egyptian or Syrian. We can cite the reception areas in the Citadel of Aleppo (main court) and Qalʿat Najm; in Aleppo the *madrasa* of al-Firdaws,* al-Sulṭāniyya,* al-Sharafiyya,* and in Damascus the Hospital (*bīmāristān*) of al-Qaymarī.* Amongst the Syrian examples are the 'rediscovered' type at Shawbak.* In Cairo, on the other hand, the elements for ventilation which are found in *madrasa*s and mosques are of different types.* ʿAbd al-Laṭīf al-Baghdādī, who visited Cairo around 1200, described the skill with which these structures were constructed, their cost, which could reach considerable amounts, and the fact that they always were open towards the north."

Ventilation at the *khān* by Joseph's Well (?)

The Biblical site known as "Joseph's Well" in English, جب يوسف in Arabic, גוב יוסף in Hebrew, is an archaeological site in Ramat Korazim in the Galilee, Israel. It is believed to be the site of the pit in Dothan, into which the Biblical figure Joseph was supposedly cast by his brothers and later sold to a caravan of Midianites on its way to Egypt (*Genesis* 37:22).[469] In fact, the historicity of the Joseph narrative cannot be demonstrated, but we still have the small 15th-century *khān* nearby:

"Near the Well is a *khān* of rectangular structure. The outer walls of 34 x 47 meters enclose a courtyard of 16 x 22 meters, with walls built with alternating layers of limestone and basalt. These are extremely thick,

[469] Information taken from https://en.wikipedia.org/wiki/Jubb_Yus—*—sef_(Joseph%27s_Well)

> between 1.5 and 2.8 meters. There are openings shaped like shooting slits, which likely served as lighting and ventilation openings, because their size and opening angles would not enable them to be used for shooting.

Here again, orientation is important. Are the slits on all four walls? Do they really provide any light? Are they of any use for ventilation?

There will be many other such sites across the Near East which will perhaps repay investigation for potential *malqaf*s.

When is a *bādahanj* not a *bādahanj* and a *campanile* not a *bādgīr*?

A very colourful anonymous European painting brought to Paris from Istanbul before 1660 and now in the Musée du Louvre was shown by the French orientalist and specialist in Islamic architecture (especially Damascus and Aleppo) Jean Sauvaget (1901-1950) to be a view in Damascus – **Pl. P8**. Note the structure on the roof to the upper left, which surely has nothing to do with a wind-catcher, but Sauvaget did not mention it anyway.[470] However, Nasser Rabbat, in his discussion of buildings represented in the late-13th-century mausoleum of the Sultan al-Ẓāhir Baybars, claimed that Sauvaget had used the '*bādahanj*' in the painting to "to identify a Mamluk city's skyline", that is, to demonstrate that the scene as Damascus (as opposed to Istanbul, as had been claimed previously). Rabbat then suggested that the dubious-looking slanting roof in his Damascus mosaic might be a *bādahanj*, which he classified as "a familiar element in the Mamluk city's skyline".[471] The Jordanian historian of Islamic art Khaled Ahmad Alhamzeh had no problem seeing in the

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[470] Sauvaget, "Ancienne représentation de Damas au Musée du Louvre" (1945/46).

[471] Rabbat, *Mamluk History through Architecture* (2010), pp. 50-53 & figs. 6 & 8.

painting the Mamluk Sultan Qanṣūh al-Ghūrī in Cairo receiving the Venetian ambassador in 1512.[472]

We digress from non-existent *bādahanj*es to the sublime, namely, to the well-known painting whose original title was '*Convenerunt in unum*', a Biblical phrase meaning "They came together in one". The painting is by the celebrated 15th-century Italian mathematician and painter Piero della Francesca, and it is better known by the more easily understandable title 'The Flagellation of Christ' – **Pl. N14**.[473] The painting is divided exactly into two halves: on the right three men stand in the foreground, a bearded foreigner, a barefoot blonde young man, and a wealthy Italian noble holding the purse-strings. On the left in the background is the flagellation scene, with the Christ-figure confronted by a soldier with a whip and by an identifiable person, the scene watched by two figures who look like the Byzantine Emperor Ioannis VIII and the Ottoman Sultan. The greatest mystery about this painting is the identity of the three men on the right. Some 50 different triads of personalities have been proposed over the past 150 years, none based on any textual evidence.

On the far right of Piero's painting we could but should not imagine the base of an Iranian-type wind-tower or *bādgīr*: this is simply a bell-tower (Italian *campanile*). The struts (Italian *tenditoi*) in front of the windows serve for attaching shades or awnings to protect the windows from the sun. In 2007 I suggested that the struts might also serve the pigeons once the cat had been let out of the bag, by which I meant that we had found the Latin acrostic which inspired the composition of the painting and by which we can now identify each of the eight persons featured in it. Each of the

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472 Alhamzeh, *Late Mamluk Patronage: Qanṣūh al-Ghūrī's* waqf *and his foundations in Cairo* (1993), pp. 67-68, following Charles Schéfer, "Note sur un tableau du Louvre" (1896).

473 King, *Astrolabes and Angels, Epigrams and Enigmas – From Regiomontanus' acrostic for Cardinal Bessarion to Piero della Francesca's* Flagellation of Christ (2007), esp. pp. 182-183.

eight figures is polysemous, that is, it represents several historical persons, and the painting itself is polysemous, with several meanings. Small wonder that it has confused so many art historians over the past 150 years! The acrostic was composed by the man in red and dedicated in Rome in 1462 to the bearded man, who was his mentor and sponsor. It was engraved on an astrolabe presented by the young German astronomer Regiomontanus to his patron, the Greek Cardinal Bessarion. Each of the eight images being polysemous and the painting itself being polysemous explains the title *Convenerunt in unum*, “They all came together in one”. This information has not yet reached the historians of Renaissance art.

Why did the Egyptians call their wind-catchers *bādahanj*?

The questions how the Egyptians came to use a Persian word for their wind-catchers and why, need not trouble us much longer. The solution has already been provided by S. D. Goitein in his masterly work *A Mediterranean Society* based on the Cairo Geniza documents. He writes:[474]

> “The rich heritage embodied in the domestic architecture revealed by the Cairo Geniza is manifested also by the large number of architectural terms of foreign origin, Aramaic, Greek, Latin, and especially Persian, which are exceedingly numerous. It does not necessarily mean that the architectural features designated by Persian terms were all imported from the East. In early Islamic times the cities of Egypt and North Africa, depleted of their Greek inhabitants, formed a colonial area for the southwest Asian bourgeoisie, an influx that became even mightier in the wake of migrations during the third and fourth centuries of Islam.* It may well be that the immigrants used Persian terms to denote structures that had been in existence in Egypt long before their arrival, perhaps changing some of the details in accordance with what they had been accustomed to in their country of origin. Thus the bay window, the closed balcony projecting

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[474] Goitein, *Mediterranean Society*, IV (1983), p. 78. The asterisks denote the presence of footnotes in the original, including a reference to Badawy 1958.

over the street, generally referred to by the Persian word *rawshan*, is designated also by a Greek term in both its Arabic and Hebrew forms. Projecting balconies had been the object of taxation (and prohibition) in classical Athens.* The wind catcher, the ventilation shaft designated by a Persian word, seems to have been in use in Egypt in Pharaonic times.* It must be remembered, too, that several of those foreign terms had become parts of Arabic speech long before the Geniza period."

This explanation may answer the questions posed above, and at least it must serve until the discovery of new evidence. For other Persian architectural terms used in the documents of the Cairo Geniza, such as *ṭāqa* for window and *dihlīz* for corridor, the reader must consult Goitein's *magnum opus*. Since there was no Arabic word for 'architect, the Arabicized Persian word مهندس, *muhandis*, from Persian اندازه, *andāzeh*, meaning 'measurement', was favoured. Turkish Arabic معمار, *miʿmār*, came later.[475]

However, we have also drawn attention to the term *bādahanj* being used in Baghdad in the 10th century, and in Syria not long thereafter (**Ch. 4**).

Who made the wind-catchers? *Bādahanj-jī*s?

"L'estensione delle ricerche è di una necessità evidente: arte copta e arte araba, vivendo e sviluppandosi fianco a fianco nello stesso paese, non potevano rimanere e non sono rimaste punto estranee l'una all'altra; i reciproci scambi sono stati quotidiani e profondi. La conoscenza di una delle arti presuppone e richiede la conoscenza dell'altra." / "The broadening of my research is an obvious necessity: Coptic and Islamic art, living and developing side by side in the same country, could not and did not remain unrelated to each other; the mutual exchanges were daily and deep.

475 I did not previously know that معمار, *miʿmār*, was used in Mamluk Egypt: see Amenah Abdulkarim, "The Mamluk miʿmār: A new interpretation of endowment deeds and chronical narratives", of which only a summary was available to me (n. 418).

> The knowledge of one art implies and requires the knowledge of the other." Ugo Monneret de Villard (1881-1954), "La missione archeologica italiana in Egitto, 1921-28" (1928), p. 276, from Silvia Armando, "Monneret de Villard and Islamic Art studies in Italy" (2013), p. 39 & 63, n. 36.

> "You can't get the wood, you know." The incredibly agèd inventor Henry Crun (played by Peter Sellers) in *The Goon Show*, BBC Home Service, 1950s. The refrain was supposedly a satirical reference to post-war austerity in Britain.

There are many questions which arise for us as a result of the fact that *bādahanj*es were so widespread im medieval Cairo. The "biography of things" is a hot topic in various academic circles, and it is not a bad idea for us to consider those who made the *bādahanj*es.[476] Who were these men? Were they organized in guilds of some sort? How did they cope with the limited supply of wood?

We have seen in a single Geniza document that around the year 1040, a workman was paid $2^3/_4$ *dirham*s for sawing wood for a *bādahanj*. This is not much to go on. But some 60 years later came the reliable report of ʿAbd al-Laṭīf al-Baghdādī that most houses in Cairo were fitted with a *bādahanj* and that these varied in price from 500 *dinar*s for a large, fancy one to a single *dinar* for a small, modest one. For the Mamluk period we seem to gape into a huge void (as into the shaft of a *bādahanj*). Our devices are mentioned in *waqf* documents for certain substantial buildings, and then, there they are on the roofs of the buildings: what happens in between? For the Ottoman period (starting in 1517) we do have some information on the trade in wood, if not on those who constructed substantial as well as simple *bādahanj*es (and those who fashioned intricate and complex *mashrabiyya*s).

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476 See, for example, Ivor Kopytoff, "The cultural biography of things: commoditization as process" (1988).

The prolific French social and economic historian of the Near East, André Raymond (1925-2011), was in a unique position to comment on the artisans and traders of late medieval Cairo, having painstakingly worked through the financial and fiscal archives from the late Ottoman period[477] which are preserved in the Cairo Court (*Maḥkama*).[478] All of the serious information in this section is taken from Raymond's masterly work.

Almost completely lacking in wood for heating (حطب, *ḥaṭab*) or for construction (خشب, *khashab*), Islamic Egypt always had to seek it from other sources.[479] After the Ottoman conquest in 1517 it had access to the forested regions in Northern Syria. "Turkish" wood for burning (*ḥaṭab rūmī*) came principally from Syria, Cyprus and Karaman; it was sold by weight and in Cairo was considered rare and precious. Wood for

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[477] André Raymond, *Artisans et commerçants au Caire au XVIII^e siècle*, 2 vols., new edn. at www.openedition.org/ifpo/5950 (2015) and 4605 (2014).

I was able to download vol. 1 in its entirety, and access the numbered paragraphs of vol. 2 chapter by chapter: hence the unusual form of references below. In the extensive extracts that follow, the presence of footnotes and references in Raymond's original is indicated by asterisks.

[478] Article "Maḥkama, Egypt" in *Enc. Islam*, 2nd edn. (VI, pp. 22-25), by Joseph Schacht, updated from 1st edn. by Aharon Layish.

[479] Raymond, *op. cit.*, I, p. 59:

> "A peu près totalement dépourvue de bois de chauffage (*ḥaṭab*) et de construction (*ḫašab*), l'Égypte musulmane avait toujours été à la recherche de sources régulières d'approvisionnement * : depuis la conquête ottomane, elle pouvait se fournir sans difficultés de ce matériau et de ce combustible dans les régions forestières qui s'étendaient depuis les montagnes de Syrie du Nord jusqu'à l'angle sud-ouest de l'Anatolie. Le bois à. brûler turc (*ḥatab rūmī*) venait principalement de Syrie, de Chypre et de Karamanie : il se vendait au poids et constituait au Caire un produit assez rare et précieux * . Le bois de construction avait à peu près la même origine : région de Mar'aš et 'Aynṭāb (Gaziantep) : port d'embarquement, Alexandrette (Iskenderun) ; massif du Taurus : ports d'embarquement, Antalya et Alaya ; Chypre ; Rhodes * . On peut supposer que le bois constituait la plus grande partie des importations en provenance de Karamanie, de Cos, de Rhodes (moyenne annuelle des importations en 1776-1781 : 1.547.266 livres, soit 26.303.522 paras), et de Chypre (103.192 livres soit 1.754.264 paras)."

construction came from the regions of Marʿash and ʿAynṭāb, via the port of Iskenderun (Alexandretta), or from the Taurus mountains via the ports of Antalya and Alaya, Cyprus and Rhodes. Wood was the major import to Egypt from Karaman, Kos and Rhodes, for which trade figures are available.

According to the Turkish traveller, historian and geographer, Evliya Çelebi, who was in Cairo during 1670-1680 or thereabouts, there were nine professions involved with wood, a total of 4,670 individuals, including: 3,000 carpenters, ‘stall-holders’ who had no work-shops but who worked ‘at home’; turners (*kharrāṭ*) came after them, 600 spread over 250 shops. [DAK: The numbers do not add up.] This large number ceases to surprise if one considers the variety of objects which they fabricated for household needs: interior grilles and other wooden decoration, *mashrabiyya*s, wooden locks, *etc*. The almost complete absence of these artisans in the registers of the *Maḥkama* is surprising and cannot be explained, as in the case of jobs relating to the food supply, by their poverty, not least because some, as we know from their wills, were quite well off.[480]

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480 Raymond, *op. cit*., I, p. 192:

“D’après Evliya Čelebi, 9 métiers étaient spécialisés dans le travail du bois, avec 4.670 individus, dont 3.000 charpentiers <<forains>> qui n’avaient pas d’ateliers, mais travaillaient <<à domicile>> ; les tourneurs sur bois (*ḫarrāṭīn*) venaient ensuite avec 600 individus répartis en 250 boutiques. Ce grand nombre n’a rien de surprenant si on tient compte de la variété des objets qu’ils fabriquaient pour l’ameublement et le logement (boiseries et grillages intérieurs, moucharabiehs, serrures de bois ...). L’absence . peu près totale de ces artisans dans les registres du Maḥkama a donc de quoi surprendre et ne peut s’expliquer, comme dans le cas des métiers de l’alimentation, que par leur grande pauvreté. La fortune moyenne des 7 artisans mentionnés (trois naǧǧār/menuisier ; trois ṣanādīqī/fabricant de boîtes ; un kursīǧī/fabricant de tables de bois) s’élevait à 13.176 paras constants, chiffre très inférieur à la moyenne de l’ensemble des artisans * : Ḥamādī al-Naǧǧār, laissa en 1699 une succession de 873 paras (724 paras constants) ; les biens de Nāṣif al-Ḏahabī, qui pourtant tenait boutique dans le ḫaṭṭ al-Ḫarrāṭīn, étaient estimés en 1718 à 4.730/4.020 paras * . Ces chiffres nous paraissent confirmer ce qui a été dit du déclin artistique du travail du bois à l’époque ottomane, en dépit de l’adresse professionnelle des artisans * .”

For the time around 1800 André Raymond identified six different groups of artisans of wood: 20 who sawed wood by length; 227 carpenters, for rafters; 205 turners; 228 makers of boxes and crates; 196 makers of grilles; 264 makers of stools.[481]

Raymond concluded that, in Egypt, working with wood, on the one side, and construction with wood, on the other, were specialities of the Copts.[482] In fact, Raymond concludes, all of the rather less involved undertakings (*des arts plutôt modestes*) were the speciality of the Copts, as, for example, the production of candles. This explains why the artisans involved are under-represented in the registers of the *Maḥkama*, so that the information they provide can only be considered as a rough guide (*dont on ne peut donc considérer les informations que comme des indications*). I have not found this association elsewhere.[483]

Thus we can cite what is perhaps the optimal modern source, namely, a lengthy article on Coptic woodwork in the authoritative *Coptic Encyclopedia*, by the French Coptologist Marie-Helène Rutschowskaya. The author describes in detail the kinds of woods available (before the Byzantine period, during which local supplies were almost exhausted), and numerous categories of objects, mainly but not only from the Louvre,

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[481] *Op. cit.*, I, p. 181:

> "Les artisans en bois se répartissaient en six corporations : 20, scieurs de long ; 227, charpentiers ; 205, tourneurs en bois ; 228, ceux qui amincissent le bois pour faire des caisses ; 196, ceux qui font des grillages ; 264, faiseurs de tabourets, *etc*..."

[482] *Op. cit.*, II, ch. 11, §11:

> "Le travail du bois et la construction étaient également des spécialités des coptes de même que la fabrication des bougies. Au total les coptes exerçaient des arts plutôt modestes *, ce qui explique qu'ils soient sous-représentés dans les registres du *Maḥkama*, dont on ne peut donc considérer les informations que comme des indications."

[483] There is not a hint of such an association with the Copts in the article "Ḳibṭ (Copts)" in the *Encyclopaedia of Islam*, 2nd edn., by the U.S.-based Egyptian Coptologist and Islamic historian Aziz Suryal Atiya (1898-1988).

and including, for example, *mashrabiyya* work.[484] However, as far as the craftsmen who made these objects are concerned, Rutschowskaya found precious little to relate. Her conclusion is surely valid for the Islamic era as well as the pre-Islamic one:

> "The activity of (Coptic) craftsmen in general and in the domain of work in wood in particular is difficult to discern because of the lack of adequate epigraphic and archaeological documentation. In addition, the subject is complex, including carpenters, joiners, cabinetmakers, and sculptors. Each category of craftsman, in fact, demanded specific technical and economic structures in the choice of materials as well as in space for workshops and types of clientele."

Amongst numerous colourful nouns and epithets for artisans from Ottoman Cairo, some with the Arabic *-ī* ending for professions, others with the Turkish *-jī* – we find *ḥarīrī* (silk), *kaʿakī* (biscuits), *zayyāt* (oil), *qumṣānī* (shirts), *kursījī* (chairs), and many more. Specifically relating to wood we find *faḥḥām* (charcoal), *khashshāb* (wood), *ḥaṭṭāb* (fire-wood), *kharrāṭ* (wood-turner) *ṣanādīqī* (boxes and crates).[485] What were the artisans called who constructed the enormous *bādahanj* of the Musāfir-khāne around 1780? Were there any artisans who called themselves *bādahanj-jī*? (Such a profession calls to mind Jamal Khashoggi, whose name خاشقجي , *Khāshuq-jī*, never to be forgotten, in Arabic stems from Ottoman Turkish *kaşık-çı*, "spoon-maker".) The medieval *nomen professionis* I like best is *khawājakī*, for a large-scale long-distance

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[484] Marie-Helène Rutschowskaya, article "Coptic woodwork" in A. S. Atiya, ed., *Coptic Encyclopedia*, vol. 7, 1991, available at http://ccdl.libraries.claremon—*—t.edu/cdm/singleitem/collection/cce/id/1923/rec/1.

[485] See, for example, Raymond, *op. cit.*, II, ch. 11, §46. Part of that world is still functioning: see Harry Johnstone with Christopher Wilton-Steer (photographer), "Alive with artisans: Cairo's al-Darb al-Ahmar – a photo essay" (2018).

merchant, already commonly used by the 15th century,[486] not least because for some 10 years of my life I was referred to as *khawāga*, mainly, but not always, a term of respect for a foreigner.

I still wonder what was the trade-name, if any, of the artisans who specialized in making the intricate *mashrabiyya*s, a term in use since the 16th century.[487] As part of the demolition of medieval Cairo in favour of French-style straight boulevards connecting old and new squares in the city, the ruler Muhammad Ali (*reg*. 1805-1848) and his son Ibrahim Pasha called for building facades to be whitewashed and later prohibited the construction of *mashrabiyya*s and promoted the use of glass window-panes. Supposedly, *mashrabiyya*s were prohibited for safety reasons, although Raymond suggests that it was a direct attempt to "legislate 'modernism'".[488]

Fortunately, aesthetics and traditionalism and common sense prevailed, and one can still find houses in Cairo with *mashrabiyya*s. Besides, tourists like *mashrabiyya*s.[489]

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(One might equally well ask whether there were there any *ʿangarībī*s or *ʿangarībjīs* in the Sudan. Until recent times, most people, including this

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486 NeIIy Hanna, *Making Big Money in 1600: The Life and Times of Isma'il Abu Taqiyya, Egyptian Merchant* (1998), pp. 18-19.

487 In the article "Mashrabiyya" in *Enc. Islam*, 2nd edn., Doris Behrens-Abouseif mentions that Mamluk *waqf* documents specify that these decorated wooden grilles should be *shughl al-kharrāṭ* rather than *shughl al-najjār*, that is, they are the work of a turner rather than of a carpenter.

488 Elshahed, *Facades of Modernity: Image, Performance, and Transformation in the Egyptian Metropolis* (2007), p. 27 & n. 16, quoting Raymond, *Artisans et commerçants au Caire au XVIII^e^ siècle* (1973), p. 303.

489 See Anonymous, "Les moucharabiehs : leur charme tout oriental ne laisse pas de bois" (2015), at egyptophile.blogspot.com (2015).

author some 50-odd years ago, would sleep on an عنقريب, ʿangarīb, indeed "more than just a bed", and one could see in the market-place artisans assembling these wooden bed-frames and fitting them with a 'platform' grid of palm fibres. The biography of these splendid devices, identifying their multiple uses, is ably and elegantly recorded by the Near East anthropologist and cultural journalist, Birgit Jerbi.[490])

Final remarks on the Cairo wind-catchers (except for their orientation)

'Old' and new resources

Over 3,000 photographs of the Cairene historical monuments taken by K. A. C. Creswell are available on-line at website of the Victoria & Albert Museum in London (collections.vam.ac.uk).

The photographic collection of Creswell is preserved at the American University in Cairo,[491] amidst other historical images (digitalcolle—*—ctions.aucegypt.edu).

Another, smaller resource is www.philographikon.com/printsegypt.html.

Some 4,500 photos of Near Eastern scenes taken between 1843 and 1920 are available online at the Ken and Jenny Jacobson Orientalist Collection, established at The Getty Research Institute.[492]

A new 3-volume, 2,500-page collected work *Encyclopedia of vernacular architecture of the world*, edited by Paul Oliver (1927-), exists but has been out of print since 2012, and I have not seen it. Future researchers may

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490 Birgit Jerbi, "The 'angarêb in Northern Sudan – More than just a bed", *MAT – Medicine Anthropology* Theory 01.03.2006, at http://medanthrotheory.org/r—*—ead/7675/the-angareb-in-northern-sudan-more-than-just-a-bed.

491 "K.A.C. Creswell photographs of Islamic architecture", at http://digital—*—collections.aucegypt.edu/cdm/landingpage/collection/p15795coll14.

492 http://www.getty.edu/research/special_collections/highlights/middle_east/.

wish to check whether this work by "over 750 specialists from more than 80 countries" contains any references to the wind-catchers of Cairo. They may find additional material in the archives of Paul Oliver at Oxford Brookes University.[493]

A substantial archive of texts and images relating to Western travellers to the Near East since *ca*. 1850 is available at Rice University, collected by Paula Sanders from 1995 onwards until about 2008, when she published her book *Creating Medieval Cairo*. This might well be useful in future research.[494]

ArchNet.org is "an open access, intellectual resource focused on architecture, urbanism, environmental and landscape design, visual culture, and conservation issues related to the Muslim world. Archnet's mission is to provide ready access to unique visual and textual material to facilitate teaching, scholarship, and professional work of high quality. Archnet is an authority, a growing repository, and a tool for teaching and learning about the architecture of Muslim societies, past, and present."[495] The materials offered include modest assortments of photos and descriptions of varying quality on medieval Islamic architectural complexes. The illustrations sometimes block out the text. To be used with caution.

In some of these resources one can still find photos and/or post-cards from the tireless Lehnert & Landrock of the so-called "German Bookshop" in Cairo.

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493 See Oliver, ed., *Encyclopedia of vernacular architecture of the world* (1997), and POVAL, listed together in the bibliography.

494 Paula Sanders, "Guide to the Travelers in the Middle East collection of travel guides, narratives and images, circa 1852-2004 MS 585", available at https://legacy.lib.utexas.edu/taro/ricewrc/00741/rice-00741.html.

495 archnet.com is a partnership between the Aga Khan Trust for Culture (AKTC) and the Aga Khan Documentation Center, MIT Libraries (AKDC@MIT).

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Any future student of medieval Cairene wind-related architecture might want to start again with the orientalist-type publications of Rosenthal/Masarwa, King and Jaubert. Each has a rich bibliography of relevant studies which could not be mentioned in this overview. The search for further references to the wind-catchers in medieval Egyptian historical, literary, legal, astronomical and encyclopaedic works will be a more daunting task. All of this could provide a diligent student with enough material for a doctoral thesis. (I wrote the above lines in early June, 2019, shortly before I became aware of the 2014 Master's thesis of Lamees al-Dasouqi.)

And maybe someone might even find a diagram of a wind-catcher in a Mamluk manuscript painting (formerly, miniature). After all, we do have an image in a 14th-century manuscript of a cross-section of a Mamluk water-driven horizontal wheel for grinding wheat – **Pl. P9**.[496]

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[496] al-Hassani, ed., *1001 inventions* (2006), p. 125, and (2012), p. 131, from a 14th-century Paris BnF manuscript (ar. 2187 or 5858?) of a treatise on cosmography by Shams al-Dīn al-Dimashqī (1256-1327), on whom see the article in *Enc. Islam*, 2nd edn., by the British orientalist Douglas Morton Dunlop (1909-1987), also Brockelmann, *Geschichte der arabischen Literatur*, II, p. 161, & SII, p. 161. Dunlop describes the treatise as a "compilation dealing with geography in the widest sense", "conspicuously uncritical", and containing "a good deal of information not to be found elsewhere". The Danish orientalist August Ferdinand Mehren (1822-1907) published the Arabic text in St Petersburg in 1866 and a French translation in Copenhagen in 1874. (The former was reprinted in the famous tradition of the al-Muthanna Library in Baghdad, and I happily purchased a copy in Damascus in 1970 with a pile of other reprints of early orientalist works.) Parts of an English translation were used in 1890 by the British orientalist and specialist of the historical geography of the Near East, Guy Le Strange (1854-1933).

See further the article "Mining technology", written by Donald Hill and Ahmed al-Hassan, in *Enc. Islam*, 2nd edn., repr. in Hill, *Studies in medieval Islamic technology* (1988), VII.

There is, however, not a word on the Cairene wind-catchers in the most recent histories of engineering in Islamic civilization by the principal experts, the late British historian Donald R. Hill (1922-1994) and his closest colleague, the late Palestinian/Syrian/Canadian scholar Ahmed Yusuf al-Hassan (1925-2012). The same is true of the 2001 UNESCO-sponsored publication *Science and Technology in Islam*, edited by al-Hassan. Perhaps this is the result of the fact that the major achievements in this field were in Iran and the Jazira. On the other hand, all these works are silent on the wind-towers of Iran and the Gulf region as well. Windmills in Iran are another matter, for they are well known (just google "windmill Iran"). Even in a splendid volume of studies of Near Eastern and Central Asian practical technology and (the threats to) its survival, the Cairo ventilators get no more than a passing mention, but they are stated to be in "Middle Egypt" instead of in "medieval Egypt".[497]

Particularly distressing is the lack of any mention of wind-towers (Iran) and wind-catchers (Cairo) in the five-volume *magnum opus* on science and technology in Islam by my late colleague Fuat Sezgin.[498]

New directions for *malqaf*s

A recent proposal by six Arab engineers at the First International Conference on Mosque Architecture in Dammam, KSA, in 2016 was for "a new configuration of porous ceramic materials integrated with a wind catcher in a minaret".[499] Their conclusion:

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497 Tapper & McLachlan, eds., Technology, *Tradition and Survival – Aspects of Material Culture in the Middle East and Central Asia* (2003).

498 Sezgin, *Science and Technology in Islam: Introduction to the history of Arabic-Islamic sciences* (2003).

499 Alfraidi & Boukhanouf & Alabdullatief & Alharbi & Ibrahim & Habeebullah, "Cool minaret: a functional element of passive cooling for mosques in hot-arid climates" (2016), esp. pp. 170-171 for the conclusion. The bibliography guides to a considerable list of non-Western literature.

> "Evaporative cooling is a native technology that has been used as part of Middle East architectural heritage for many centuries. It provides thermal comfort in buildings for occupants in the harshest of weather conditions with minimum impact on the natural environment. This work has attempted to apply the principle of evaporative cooling into the mosque minaret to extend its functionality to provide cooling, by incorporating wind catcher and porous ceramic materials. Both sub-wet bulb evaporative cooling and the use of optimized porous ceramic structures within a minaret have the potential to enhance thermal comfort in mosques in hot and dry climates, while minimizing the energy consumption."

If someone had thought of this a thousand and more years ago, history would have been different.

Meanwhile, in a remarkable new luxury-apartment development-project in the Cairo suburb of Heliopolis, by the Belgian ecological architect Vincent Callebaut labelled "The Gate" we find the *malqaf* exploited as a prominent feature.[500] One of eight "Green Architecture Features" integrated in the project is: "Windcatchers transformed into mega-trees in the middle of each green patio" – **Pl. V8**. The architects' blurb continues:

> "The windcatchers are known in traditional Egyptian architecture in Ancient Egypt as demonstrated in Windcatchers on the Pharaonic house of Neb-Ammun, Egypt, 19th Dynasty, British Museum. It was revived in Neo-Islamic architecture as the works of Hassan Fathy.
>
> "In Egypt the windcatchers are known as 'Malqaf'. The windcatcher can function in three ways: directing airflow downward using direct wind entry, directing airflow upwards using a wind-assisted temperature gradient, or directing airflow upwards using a solar-assisted temperature gradient.

[500] http://vincent.callebaut.org/object/141029_thegate/thegate/projects. A review of this "impressive array of green technology" is in https://www.domain.c—*—om.au/news/cairos-the-gate-heliopolis-building-raises-the-bar-for-green-technology-20170609-gwo06h/.

"The 9 mega-trees are in fact 9 big windcatchers and the potential benefits regarding this natural passive cooling system may include:

- Improved passive cooling during warm season (mostly on still, hot days).

- Improved night cooling rates.

- Enhanced performance of thermal mass (cooling, cool storage).

- Improved thermal comfort (improved air flow control, reduced draughts)."

There you have it. We've come a long way in 1,001 years!

Those who do not like *orientaliste* paintings and claim that they exploit women will not find any sexist images amongst the orientalist paintings and early photos of real *bādahanj*es shown in **Part II**. However, the website of "The Gate" offers the sight of a woman in a *negligée* looking out of an apartment window at the fake fronds of an inverted conical palm-tree-like *malqaf*. Perhaps she is the *khawāgāya* (French woman from Paris) in Hassan Fathy's well-known novel *al-Jabal* ("The Mountain").

Loose ends

Inevitably after conducting a study of any aspect of human activity which lasted over a millennium there will be some loose ends such as I list here:

- It is not certain that the images of Ancient Egyptian "wind-catchers" are indeed wind-catchers. Particularly the image showing two "catchers" facing opposite directions can be explained as representations of rather unusual roof formations such as are attested elsewhere on a model of a house – see **Pls. A1-3**. The presence of potential wind-catchers in Ancient Egyptian illustrations and Coptic Christian architectural remains somewhat problematic.
- The half-dozen references to the term *bādahanj* from the 10th century are ʿIrāqī and Syrian rather than Egyptian. The history of these devices in al-ʿIrāq and Syria has yet to be written.
- The origin of the Cairo wind-catchers in the 10th century is unclear. It may be that they were introduced at the time of the founding of

the new city in 969, or shortly thereafter. It seems more likely that they were already well well-established in Fustat by the time Cairo was founded.

- Ibn Yūnus was in his teens when the City was founded. What was his role in the culture of the *bādahanj*es? Before his death in 1009, he apparently wrote on the orientation and shape of the wind-catchers, and also compiled an astronomical table for orienting them. Under what auspices did this take place?
- However, the Cairene wind-catchers came into being, they were immediately given an Arabicized Persian name, *bād͟hāhanj*. We do not know when and how, and the available sources are silent.
- Details about the construction of the *bādahanj*es – wind-scoops, air-shafts, closing devices, *etc*. – are to be found in the study of Olivier Jaubert.[501]
- What other references to the omnipresent *bādahanj*es are there in the vast medieval Arabic literature and in early modern Egyptian historical and geographical sources? This is something for future researchers.
- Also of academic interest is the way in which wind-catchers were shown around the city in 19th and 20th-century images. Which parts of the city were most likely to have them?
- We may never discover a *bādahanj*-maker's manual in the as yet uncatalogued and untapped medieval manuscript sources. The most likely source for new information are notes (فائدة, *fā'ida*, pl. فوائد, *fawā'id*) or marginalia (في الهامش, *fī 'l-hāmish*), particularly as recorded in manuscripts of mixed contents (مجموعة, *majmūʿ*, pl. مجاميع, *majāmīʿ*). To cite one very good example, the notes on the *bādahanj* attributed to Ibn Yūnus, originally penned over a thousand years ago, are found only in the 14th-century Egyptian mixed manuscript preserved in the Biblioteca Ambrosiana in Milan!

501 Jaubert, "Capteurs de vents" (1995), pp. 174-176.

We now leave the Cairo wind-catchers in order to concentrate on what we can learn from astronomical texts about their orientation, which, it turns out, is related to the layout of the Fatimid/Mamluk city and the two principal *qibla* directions that underlie it. But first we should address the question: was there any astronomy in Muslim Egypt?

Part Ib
The secrets of the Cairo wind-catchers

New orientations

> "When mathematical propositions refer to reality, they are not certain; when they are certain, they do not refer to reality." Christian Norber-Schulz, *Existence, Space and Architecture* (1971), p. 10, quoted in Akel Kahera, "The accuracy of the *qibla* axis: a legal debate" (2014), p. 201.

It is an unfortunate fact that the orientations of medieval Cairene religious architecture, even the major edifices and complexes, have never been systematically and properly measured, or seriously discussed in the literature with the care and attention that they deserve. Clearly much of that architecture follows the outlines of the city-plan, but that has never been understood (before it was revealed by the wind-catchers), and much of it does not follow those outlines and indeed is boldly independent of the surrounding street-plan. Further, there are religious complexes which do not seem to be facing Mecca at all, or in which two different *qibla*s have been used in different *miḥrāb*s within the same edifice.

Nowadays many orientations can be measured quite simply from modern maps on the internet, bearing in mind that the internal orientation might be different from the external one. However, such measurements must not be interpreted in terms of the modern *qibla* for Cairo, which is irrelevant to any discussions of medieval architecture. (Measurements of the orientations of early mosques by individuals who have no idea about the methods used by the early Muslims to determine the *qibla* may in themselves be valid, but interpreting them has so far only led to absurd conclusions because these individuals have compared the historical orientations with the modern *qibla*s.)

In the present endeavour I do not propose to investigate the orientations themselves, not least because I have not measured them, but rather to present what various medieval texts tell us about them. May this encourage younger investigators to consider the edifices together with their orientations and within the surrounding street-pattern (if it is original).

In the sequel we present a brief outline of astronomy in the Muslim world for well over 1000 years. This is followed by a few remarks on astronomy in medieval Egypt. Then we consider the two different and independent traditions of finding the *qibla* and their impact on the orientation of religious architecture. The *qibla* in medieval Cairo is a complicated topic, but it is a necessary background to understanding what the astronomical sources tell us about the wind-catchers. Later we shall mention what some few modern scholars have said about orientations in Cairo. These are the exceptions, since most people who have written on Cairene architecture have ignored orientations altogether.

(12 — Excursus: Aspects of astronomy in the Islamic world)

"Wherever in the medieval world there were tables, real astronomy was practiced; where tables were lacking there were only dilettantes and dabblers." James Evans, *Ancient Astronomy* (1998), p. viii.

"Mathematical theories [?] were developed in medieval times by the Arabs [*sic*], from around the ninth century AD. They had a reputation as excellent observers; it is true to say that the Muslims excelled in every branch of scientific knowledge [here quoting DAK]. ... ... On the other hand, it is also true [*sic*] that the main concern of the Arabs was astrological, and here we come to another obstacle in the way of real progress." Patrick Moore, the well-known British populariser of astronomy who was poorly informed on the history of his subject, quoted from the introduction to Christopher Walker, ed., *Astronomy before the Telescope* (1996), p. 12.

"In Baghdad, the Persian *zīj* tradition of enumerating [?] and tabulating data [*sic*] was coupled [*sic*] with various instruments for measuring celestial spheres [!!] in an effort to shore up the Ptolemaic tradition [*sic*]." This pithy quote comes from a recent learned volume on "global patterns of scientific exchange". But note that the tables in *zīj*es contained values that had been calculated, and no instrument has ever been constructed which can measure celestial spheres. Also, Indian mathematical methods were often more useful than Greek ones. ... ... Muslim astronomers, despite their great mathematical virtuosity, were not able to make the transition from "the closed world to the infinite universe," to use the phrase of the French historian of science, Alexandre Koyré." Toby E. Huff, "Understanding the place of science in Islamic civilization" (2007), p. 106. (Such claims misunderstand pre-telescopic astronomy. Toby Huff, who is not well versed in the history of Islamic astronomy, has been pushing this theme for decades in spite of criticism by experts.)

This is not the place to present a survey of Islamic astronomy, a task which has been attempted several times elsewhere.[502] Much of the text of the next few sub-sections is taken unashamedly from my chapter "Islamic Astronomy" in the 1996 British Museum publication *Astronomy before the Telescope*, which volume, in spite of its introduction by someone innocent of the history of astronomy, also provides reliable accounts of astronomy in many other civilizations. There is a substantial amount of serious literature on aspects of Islamic astronomy to which the reader can turn for more information.[503]

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[502] See Nallino, "Islamic astronomy" (1921), King, "Islamic astronomy" (1996), Morrison, "Islamic astronomy and astrology" (2010). For a more recent survey of Islamic theoretical astronomy (هيئة, *hay'a*) see Ragep, article "Astronomy" in *Enc. Islam THREE*.

[503] The interested reader can find reliable accounts of different aspects of the history of Islamic astronomy in such works as:

– Three recent studies in Scheiner & Janos, eds., *The Place to Go: Contexts of learning in Baghdād, 750-1000* (2014), namely: Damien Janos, "Al-Ma'mūn's patronage of astrology: Some biographical and institutional considerations"; Antoine Borrut, "Court astrologers and historical writing in early ʿAbbāsid Baghdād: An appraisal"; and Johannes Thomann, "From lyrics by al-Fazārī to lectures by al-Fārābī: Teaching astronomy in Baghdad (750-1000 C.E.)";

– George Saliba, "The role of the astrologer in medieval Islamic society" (1992), and *A History of Arabic Astronomy – Planetary theories during the Golden Age of Islam* (1994);

– Julio Samsó, *On both sides of the Strait of Gibraltar – Studies in the history of medieval astronomy in the Iberian Peninsula and the Maghrib*, in press with Brill;

– Sonja Brentjes, "Shams al-Dīn al-Sakhāwī on muwaqqits, mu'adhdhins, and the teachers of various astronomical disciplines in Mamluk cities in the 15th Century" (2008);

For the technical side, see:

– theoretical astronomy: article "Astronomy" by Jamil Ragep in Enc. Islam THREE;

It is not generally known that in historical Islamic civilization, astronomy was practiced at two different levels. The first was what we now call "folk astronomy", based on what one can see in the sky, without observation, theory, instruments or calculation. Timekeeping was by watching shadow-lengths by day and the lunar mansions by night. The second was what we now call "mathematical astronomy", involving serious observation programmes, theories about and models for the motions of the sun, moon and planets, instruments for observation and calculation, and extensive tables for computing celestial positions. Timekeeping was by using sophisticated tables and by serious instruments.

Arab star-lore

> "The Arabs – inhabitants of the Arabian Peninsula, mostly Bedouins – had a good knowledge of the stars since ancient times. They used the fixed stars for orientation in their nightly desert travels (*ihtidā'*), to determine seasons and to predict weather, especially rain. They had proper names for a good dozen prominent stars and other celestial objects. ... ... In addition, several hundred

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– practical astronomy: DAK & Julio Samsó & Bernard R. Goldstein, "Astronomical handbooks and tables from the Islamic world" (2001), in anticipation of the new *zīj* survey by Benno van Dalen (forthcoming);

– astronomical timekeeping: DAK, *In Synchrony with the Heavens*, vol. 1 (2004); and

– instruments: DAK, *Synchrony*, vol. 2 (2005); ... ...

to mention just a few.

Unfortunately, nobody ever thought to establish a cumulative bibliography for the history of Islamic astronomy and mathematics, such as exists for the history of Islamic art and architecture (Sinclair). Ironically it was Archie Creswell who in 1947 published a bibliography on "modern" studies on Islamic astrolabes, which fact led to our first encounter at the American University in Cairo!

names for smaller, less conspicuous stars and asterisms were invented, most probably by poets, at various times and in various tribes and regions ... ." Paul Kunitzsch, article "al-Nuḏjūm (stars)" in *Enc. Islam*, 2nd edn., VIII (1993), p. 97a.

The Arabs of the Arabian Peninsula before Islam possessed a simple yet developed astronomical folklore of a practical nature. For the Bedouin of the desert this involved a knowledge of the risings and settings of the stars, associated in particular with the acronychal settings of groups of stars and simultaneous heliacal risings of others, which marked the beginning of periods called نوء, *naw'*, plural انواء, *anwā'.* These *anwā'* eventually became associated with the 28 lunar mansions (منازل القمر, *manāzil al-qamar*)*,* a concept apparently of Indian origin. A knowledge of the passage of the sun through the twelve signs of the zodiac, associated meteorological and agricultural phenomena, the phases of the moon, as well as simple time-reckoning using shadows by day and the lunar mansions by night, formed the basis of later Islamic folk astronomy, which flourished separately from mathematical astronomy in Islamic society.[504]

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[504] On Islamic folk astronomy see the recent overviews in Clive Ruggles, ed., *Handbook of Archaeoastronomy and Ethnoastronomy*, 3 vols., (2015): Petra G. Schmidl, "Islamic folk astronomy", pp. 1927-1934; and Daniel Martin Varisco, "Folk astronomy and calendars in Yemen", pp. 1935-1940. See also Varisco, "The origin of the *anwā'* in Arab tradition" (1991), and "Islamic folk astronomy" (2000). The literature before *ca*. 1050 is surveyed by Fuat Sezgin in his *Geschichte des arabischen Schrifttums*, vol. VII (1979). See also the *DSB* article "Ibn Qutayba" by Paul Kunitzsch.

On the relationship of folk astronomy to agricultural practices see the numerous publications by Daniel Varisco, some of which were reprinted in his *Medieval folk astronomy and agriculture in Arabia and the Yemen* (1997).

Early modern writings were unaware of the practical side of Islamic folk astronomy. See now Schmidl, *Volkstümliche Astronomie im islamischen Mittelalter: Zur Bestimmung der Gebetszeiten und der Qibla bei al-Aṣbaḥī, Ibn Raḥīq und al-Fārisī* (2007), also King, *In Synchrony with the Heavens*, vol. 1 (2004), III: 457-528,

Since the sun, moon and stars are mentioned in the *Qur'ān*, an extensive literature dealing with what may well be labelled Islamic folk cosmology arose.[505] This was inevitably unrelated to the more "scientific" Islamic tradition based first on Indian sources and then predominantly on Greek ones. Since it is also stated in the *Qur'ān* that man should use these celestial bodies to guide himself, the scholars of the religious law occupied themselves with folk astronomy. We shall mention below various treatises dealing with the determination of the direction of Mecca by non-mathematical means.

More than 20 compilations on the pre-Islamic Arabian knowledge of celestial and meteorological phenomena as found in the earliest Arabic sources of folklore, poetry, and literature, are known to have been compiled during the first four centuries of Islam. The best known is that of Ibn Qutayba, written in Baghdad about the year 860. (It is worthy of note that the revisionists, who try demolish the standard history of Islam, have not yet ventured to suggest that all this folk-scientific material was fabricated in later centuries. The reason is that so few people know anything about it.) Almanacs enumerating agricultural, meteorological, and astronomical events of significance to local farmers were also compiled: several examples of these survive from the medieval Islamic period, one such being for Cordova in the year 961. The Yemen possessed a particularly rich tradition of folk astronomy, and numerous agricultural almanacs were compiled there. But there was also a serious tradition of

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and IV: 529-622, on the ways in which simple shadow-schemes were used in early Islamic practice, to the extent of influencing the Islamic prayer ritual to this day.

505 This is well represented by a popular treatise by the late-15th-century polymath al-Suyūṭī, edited and translated by one of most brilliant orientalists of the 20th century, Anton Heinen (1939-1998) – see his *Islamic cosmology* (1982), and also my review. On al-Suyūṭī, see, for example, the article by Aaron Spevack in *Essays in Arabic Literary Biography*, II, pp. 386-410, and, most recently, Ghersetti, ed., *Al-Suyūṭī, a polymath of the Mamlūk period* (2016).

mathematical astronomy which flourished in the Yemen for over a thousand years.[506]

Persian and Indian sources

The earliest astronomical texts in Arabic seem to have been written in Sind and Afghanistan, areas conquered by the Muslims already in the 7th century. Our knowledge of these early works is based entirely on citations from them in later works. They consisted of text and tables and were labelled زيج, *zīj*, after a Persian word meaning "cord" or "thread" and by extension "the warp of a fabric", which the tables vaguely resemble. The Sasanian *Shahriyārān Zīj* in the version of Yazdigird III was translated from Pahlavi into Arabic as the *Shāh Zīj,* and the astronomers of the Caliph al-Manṣūr (*reg*. 754-775) supposedly chose an astrologically auspicious moment in 762 to found his new capital Baghdad using probably an earlier Pahlavi version of this *zīj*. The various horoscopes computed by Māshā'allāh (Baghdad, *ca*. 800) in his astrological world history are based on it.

Significant for the subsequent influence of Indian astronomy in the Islamic tradition was the arrival of an embassy sent to the court of the Caliph al-Manṣūr from Sindh *ca*. 772. This embassy supposedly included an Indian well versed in astronomy and bearing a Sanskrit astronomical text apparently entitled the *Mahasiddhanta* and based partly on the *Brahmasphutasiddhanta*. The Caliph ordered al-Fazārī to translate this text into Arabic with the help of the Indian. The resulting *Zīj al-Sindhind al-kabīr* was the basis of a series of *zīj*es by such astronomers as al-Fazārī, Yaʿqūb ibn Ṭāriq, al-Khwārizmī, Ḥabash, Ibn Amājūr, al-Nayrīzī, and Ibn al-Adamī, all prepared in al-ʿIrāq before the end of the 10th century. The *Sindhind* tradition flourished in al-Andalus, mainly through the influence

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506 King, *Mathematical astronomy in medieval Yemen* (1983).

there of the *Zīj* of al-Khwārizmī. As a result, the influence of Indian astronomy is attested from Morocco to England in the late Middle Ages.

Greek sources

The *Almagest* of Ptolemy of Alexandria *ca*. 150 was the most important astronomical work of Antiquity and also of the Islamic and European Middle Ages. It was translated at least five times in the late 8th and 9th centuries. The first was a translation into Syriac and the others were into Arabic, the first two under the Caliph al-Ma'mūn in the middle of the first half of the 9th century, and the other two (the second an improvement of the first) towards the end of that century. All of these were still available in the 12th century, when they were used by Ibn al-Ṣalāḥ for his critique of Ptolemy's star catalogue. The translations gave rise to a series of commentaries on the whole text or parts of it, many of them critical and one, by Ibn al-Haytham (*ca*. 1025), actually entitled "Doubts about Ptolemy" (*al-Shukūk*). The most commonly-used version in the later period was the recension of the late-9th-century version by the polymath Naṣīr al-Dīn al-Ṭūsī in the mid-13th century. Various other works by Ptolemy, notably the *Planetary Hypotheses* and the *Planisphaerium*, and other Greek works, including the short treatises by Autolycos, Aristarchos, Hypsicles, and Theodosios, and works on the construction known as the analemma for reducing problems in three dimensions to a plane, were also translated into Arabic; most of these too were later edited by al-Ṭūsī. In this way Greek planetary models, uranometry, and mathematical methods were available to the Muslims over the centuries. Their redactions of the *Almagest* contained not only reformulations and paraphrases of its contents but also "corrected, completed, criticized, and brought (the contents) up to date both theoretically and practically" (George Saliba); most of this material has not been studied in modern times. The *Almagest* in its Greek, Syriac, Arabic and Latin versions continues to be of importance today, if only to historians. The long-term project at the

Bavarian Academy of Sciences in Munich entitled *Ptolemaeus Arabus et Latinus*[507] is:

> "dedicated to the edition and study of the Arabic and Latin versions of Ptolemy's astronomical and astrological texts and related material. These include works by Ptolemy or attributed to him, commentaries thereupon, and other works that are of immediate relevance to understanding Ptolemy's heritage in the Middle Ages and the early modern period up to 1700 A.D."

Fortunately, at least for us historians, Islamic astronomy went far beyond the Ptolemaic tradition.

Islamic astronomy in the 9th and 10th centuries

By the 9th century, at least in al-ʿIrāq and Iran, a new astronomy flourished, and Arabic had become the new language of science. The reader can sift through the pages of the sixth volume (1978) dealing with astronomy of the monumental *Geschichte des arabischen Schrifttums* (*History of Arabic Literature*) by my former colleague Fuat Sezgin (1924-2018) and find dozens of authors writing treatises about all aspects of practical and theoretical astronomy before *ca*. 1050, in what was no less than a cultural and scientific Renaissance.

One of the activities of the early Muslim astronomers was to control the astronomical parameters they inherited from their predecessors. To this end in the mid 9th century they undertook observations in Baghdad of solar and lunar eclipses and planetary conjunctions. Their observation program was continued in the late 10th century by Ibn Yūnus in Cairo, who has preserved for us all the observation reports of his predecessors and himself (alas without any indication of the way in which the data was exploited to obtain improved parameters) – see **Ch. 13** below. Also in the mid 9th century, observations were conducted in the plain of Sinjar to

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[507] For more information see ptolemaeus.badw.de.

(re)measure the circumference of the earth by investigating the distance on earth corresponding to a 1° difference in the solar meridian altitude and multiplying that by 360; the value obtained was indeed an improvement over the Greek value.[508]

Islamic astronomical literature (selected)

The astronomical literature of the Islamic period can be classified as follows:

- folk astronomy (الانواء, *al-anwā'*); and Islamic folk cosmology (الهيئة السنية, *al-hay'a al-sunniya*)
- theoretical astronomy, cosmology (علم الهيئة, *ʿilm al-hay'a*)
- observational astronomy (علم الرصد, *ʿilm al-raṣad*)
- mathematical astronomy (علم الزيجات, *ʿilm al-zījāt*) and annual ephemerides (علم التقويم, *ʿilm al-taqwīm*)
- astronomical timekeeping (علم الميقات, *ʿilm al-mīqāt*)
- astronomical instrumentation (علم الالات, *ʿilm al-ālāt*)
- astrology (علم احكام النجوم, *ʿilm aḥkām al-nujūm*).

The Islamic *zīj*es

> "Of the masses (of Islamic astronomical manuscripts) it is possible to isolate a fairly well-defined group of works, the *zīj*es, which in the opinion of the author, make up the most significant and historically rewarding subclass of the whole. A *zīj* consists essentially of the numerical tables and accompanying explanation sufficient to enable the practising astronomer, or astrologer, to solve all the standard problems of his profession, *i.e.*, to measure time and to compute planetary and stellar positions, appearance, and eclipses. ... . This paper is a survey of the number,

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508 See the references to the various accounts of this undertaking cited in King, "Too many cooks ... – A newly-rediscovered account of the first Islamic geodetic measurements" (2000), and n. 607 below.

distribution, contents, and relations between *zīj*es written in Arabic or Persian during the period from the 8th through the 15th centuries ... ." Edward S. Kennedy, "A Survey of Islamic astronomical tables" (1956/1990), p. 123 / p. 1. (Kennedy single-handedly identified about 125 *zīj*es. The number now known is well over 200; also, a substantial amount of tables has come to light that are not contained in *zīj*es.)

"Few textual or material artefacts create research questions that neatly overlap with individual expertise. Put bluntly, anyone who works on any larger topic will inevitably reach the limits of their specific learning. … ." Boris Liebrenz, "The history and provenance of the unique *Dustūr al-munağğimīn* manuscript, BnF arabe 5968 – A re-assessment" (2020), p. 39. (Blunt, but true. Indeed, never were truer words written about 'research questions'. Also true of the *Dustūr*, a *zīj* whose tables have not been studied for decades.)

A *zīj* is an astronomical handbook with tables, after the manner of Ptolemy's *Almagest* (text and tables) and *Handy Tables* (more tables). Some 250 works of this kind were compiled between the 8th and the 19th centuries.[509] Those of al-Khwārizmī (Indian tradition) and al-Battānī (Ptolemaic tradition) were known in al-Andalus and were influential in the *Toledan Tables*, which in turn were important for centuries in medieval Europe. These two *zīj*es were the first to be published by modern scholars, al-Khwārizmī by Heinrich Suter and Otto Neugebauer, al-Battānī by Carlo Alfonso Nallino. The *Zīj* of Ibn Yūnus had been explored by Caussin de Perceval and that of Ulugh Beg of Samarqand by Louis-Amélie Sédillot. When Edward Kennedy embarked on a survey of Islamic *zīj*es he identified some 125 in his 1956 *Survey*. Between the two of us we

[509] See Kennedy, "Survey of Islamic astronomical tables" (1956); King & Samsó & Goldstein, "Astronomical handbooks and tables from the Islamic world" (2001); and the article "Zīdj" in *Enc. Islam*, 2nd edn. See the next note for a new and more detailed survey currently in progress.

identified a few dozen more. Then Benno van Dalen undertook a new survey, with more details and parameters and comparative analyses, and he is currently handling over 250 *zīj*es. His forthcoming publication is awaited with anticipation.[510]

The following aspects of mathematical astronomy are handled in a typical *zīj*:

- chronology: tables for and conversion between Muslim, Byzantine, Iranian, Jewish and other calendars
- sexagesimal notation (all numbers to base 60, thus, in medieval notation x y z is represented in modern notation $x;y,z = x + y/60 + z/3600$)
- trigonometry: sine function, shadow (cotangent), and occasionally other functions
- spherical astronomy: solar declination, right & oblique ascensions, rising amplitudes, time and azimuth from solar / stellar altitudes
- solar, lunar and planetary mean motions (linear functions of time)
- solar, lunar and planetary equations (adjustments to mean positions)
- lunar and planetary latitudes
- planetary stations (direct & retrograde motions)
- parallax (actual *vs*. apparent position of sun and moon)
- solar and lunar conjunctions and eclipse predictions
- lunar crescent visibility (for regulating the Islamic lunar calendar), also planetary visibility
- mathematical geography (lists of cities with geographical coordinates: longitudes & latitudes)
- determination of the direction of Mecca
- uranometry (tables of fixed stars with coordinates: longitudes & latitudes and/or ascensions & declinations)
- mathematical astrology.

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510 For more details see www.bennovandalen.de.

There are numerous sets of tables of which are not generally contained in *zīj*es. These include:

- sexagesimal multiplication tables (with 3,600 or 216,000 entries)
- trigonometric tables for each minute of argument
- tables for timekeeping by the sun and/or stars (see below)
- tables for regulating prayer-times (see below)
- tables giving the direction of Mecca (see below)
- tables of auxiliary functions for solving the problems of spherical astronomy for all latitudes
- tables of polar / Cartesian coordinates for marking horizontal / vertical sundials; tables for marking astrolabes and quadrants
- tables of planetary equations for two arguments that can be taken directly from mean-motion tables

Ephemerides

One of the purposes of the extensive solar, lunar and planetary tables in *zīj*es was the preparation of annual ephemerides, displaying the positions of the sun, moon and five naked-eye planets for each day of the year.[511] These were called تقويم, *taqwīm*, since the operation of finding the true longitude from the mean longitude was called قوّم, *qawwama*, of which *taqwīm* is the verbal noun. Such ephemerides were prepared already in Abbasid times, but they had a singularly high rate of attrition since they could be thrown out at the end of the year for which they were prepared.

511 See the article "Taḳwīm (تقويم, ephemeris & almanac)" by Michael Hofelich (astronomical ephemeris) and Daniel M. Varisco (agricultural almanacs) in *Enc. Islam*, 2nd. edn. For analyses of surviving fragments of early ephemerides see the numerous studies of Johannes Thomann mentioned in n. 576. For the information on lunar crescent visibility in different kinds of *taqwīm*s, see King, "Lunar crescent visibility predictions in medieval Islamic ephemerides" (1991.

In the modern literature, the term *taqwīm* is often inappropriately rendered as 'calendar'.

al-Bīrūnī (Ghazna, *ca*. 1025) has preserved for us an extract from a *taqwīm* of his time;[512] two complete Rasulid Yemeni ephemerides from Sanaa (727 H = 1326/27) and Taiz (808 H = 1405/06) survive and await detailed study;[513] and we have literally hundreds of Ottoman ephemerides. As we shall see in **Ch. 13**, the majority of surviving fragments of early *taqwīm*s are from Cairo. One of the main purposes of the annual ephemerides was to provide information of astrological significance based on the daily position of the moon relative to the sun and planets and on the occurrence of eclipses.

Astronomical instruments

Instrumentation was an important component of Muslim astronomical activity, involving four main kinds of astronomical instruments.[514] Some

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512 al-Bīrūnī, *al-Tafhīm*, Section 321, pp. 186-191.

513 See King, *Mathematical astronomy in medieval Yemen* (1983), p. 33, no. 11 & p. 39, no. 22, & pls. 2-3; *Cairo Survey* (1986), no. E11 and pl. XXI with caption on p. 200; and *In Synchrony with the Heavens*, vol. 1 (2004), pp. 419-422.

514 For overviews of Islamic instrumentation see the *Enc. Islam*, 2nd edn., articles "Marṣad (observational programmes)"; "Asṭurlāb (astrolabe)"; "Shakkāziyya (universal projections)", "Rubʿ (quadrant)"; "Kura (celestial sphere/globe)"; "Mizwala (sundial)"; and "Ṭāsa (magnetic compass)". The article "Astrolabe, quadrant and computing devices" in *Enc. Islam THREE* is of less value because of editorial length restrictions.

On Islamic celestial globes see Savage-Smith, *Islamicate celestial globes* (1985). For more details on various kinds of instruments see King, *Islamic astronomical instruments* (1987/1995), and *idem*, *In Synchrony with the Heavens*, vol. 2 (2005), X: 1-110 "Astronomical instrumentation in the medieval Islamic world", and XI-XII: 111-336 (quadrants), and XXIII: 337-914 (astrolabes). The overview of stuff on the astrolabe in King, "The Astrolabe – What it is and what it is not" (2018) deals with serious modern writings (Part I) as well as some of the rubbish on the internet (Part II).

of these were of Greek origin and inspiration, others were of Muslim design. These instruments were used throughout the medieval Islamic period, filtered slowly and not completely into medieval Europe, and Renaissance instruments closely resemble them, not least because they were used for the same purposes.

First, we have observational instruments, mainly meridian rings, and equatorial rings, and armillary spheres. They were mainly used in observation programmes. They can be used to find the local latitude and solar declination, as well as to find the coordinates of stars. This takes us far from our main topic.

Second, we have instruments such as the celestial globe and the astrolabe, each serving as a model of the heavens for a specific (adjustable) latitude. The globe displays the starry heavens and is fitted inside a horizontal frame to hold it and a vertical frame for tilting the axis of the globe to the terrestrial latitude. Well over a hundred survive, although few predate 1500. The astrolabe, of Greek origin and adopted by the Muslims in the 8th century, is a projection into two dimensions of the celestial globe and various base-circles on it, as well the coordinate system of the sky of the observer. Originally it was fitted with seven sets of latitude-based markings, corresponding to the seven climates of Antiquity, thus making it universal. One variety included a set of universal markings (*shakkāziyya*), which could be used at any latitude. The astrolabe could be pocket-size and was particularly useful for reckoning time of day and night. Several hundred survive, though only a few dozen from before 1500.

On Islamic sundials see the article "Mizwala (sundials)" in *Enc. Islam*, 2nd edn.; King, *In Synchrony with the Heavens*, vol. 2 (2005), X: 81-98; Charette, *Mathematical instrumentation in 14th-century Egypt & Syria* (2003), pp. 181-208; Ferrari, *Le meridiane dell'antico Islam* (2011); also a popular survey in Berggren, "Sundials in medieval Islamic science and civilization" (2001).

The universal horary quadrant, featuring a graphical set of hour-markings, was based on a simple Indian approximate formula for timekeeping. It developed in 8th- or 9th-century Baghdad and was used in the Muslim world and in Europe for close to a millennium. Universal horary quadrants were found on the backs of most Islamic and European astrolabes, although only a few decades ago was it discovered how and why they worked. Their inclusion on astrolabes has been labelled an "empty ritual" but this is true only for European latitudes because they perform precisely the function for which they were devised for the latitudes of the Fertile Crescent.

From the standard astrolabe was developed in 12th-century Cairo the astrolabic quadrant for a specific latitude. A few brass astrolabic quadrants survive from 14th-century Damascus, and dozens of wooden ones from 18th- and 19th-century Istanbul.

Third, we have sundials, of which numerous varieties were known already in Greek and Roman Antiquity. The Muslims adopted sundials with great enthusiasm. Already around 850 they were preparing tables (of polar coordinates) for marking the hour lines on horizontal sundials for a range of latitudes. Tables for constructing vertical sundials inclined at different angles to the vertical for all latitudes came later. In many places, sundials were a feature of the major mosques, not least because they could show the time before the midday and mid-afternoon prayers, which were defined in terms of shadow lengths. The number of surviving marble sundials from before around 1500 can be counted on the fingers of two hands.

Fourth, there are miscellaneous instruments such as the magnetic compass, dry and wet, and the *qibla*-indicator and the compendium, a multi-purpose instrument involving a sundial for timekeeping and means for finding the *qibla* in various localities. World-maps centred on Mecca with localities marked on a specially designed cartographical grid from which one could simply read off the *qibla* and the distance to Mecca were conceived and constructed on metal: the theory goes back to treatises from the 10th and 11th centuries. Three examples are known, all from 17th-century Isfahan. Although brilliant in their conception and beautiful in

their execution, these scientific works of art were of little practical use because tables of *qibla*-values were available, as well as less complicated instruments. (In the most recent literature, they have been called "astrolabe maps" although they have nothing to do with astrolabes.)

We shall return below to a discussion of some examples of Mamluk instrumentation.

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Detailed investigation of some of the few surviving instruments as historical 'documents' rather than just museum exhibits has proved worthwhile.[515] For example, a small horizontal sundial from Tunis dated 1345/46 has revealed the reason behind the very curious definitions of the times of the midday and mid-afternoon prayers in terms of the shadow increases over the midday minimum. This is not bad for a start: the reasoning behind these definitions was previously unknown.

Another example is an astrolabe preserved in the Metropolitan Museum of Art in New York. It is signed by a Yemeni sultan in 1291 but in the 1960's was deemed a fake by an expert because "there was no astronomy in the Yemen". Now we know there was over a thousand years of astronomy in the Yemen, and that the same sultan wrote an enormous book on astronomical instruments, appended to which there are reports by his teachers approving six astrolabes that he made, one of which survives and is the one in the Met.

One final example: a glazed ceramic graduated wet-compass bowl, much appreciated by art historians, in which a magnetized needle could float, dedicated to the Ottoman Sultan in Damascus *ca*. 1520. Under the glazing are the names of 40-odd localities and their *qibla*-directions, mainly miscopied from a manuscript and a total mess, thus rendering the instrument, undoubtedly genuine, completely useless from a practical

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[515] All of these instruments are described in King, *In Synchrony with the Heavens*, vol. 2 (2005).

point of view. It would be very interesting to know how this came about, and how the maker fared.

It is generally assumed that Muslims in historical times used tools like the astrolabe to regulate to regulate the times of their prayers and find the *qibla*. They did not.

Tables for astronomical timekeeping

Tables which serve timekeeping by the sun and stars were first compiled in Baghdad in the 10th century, and later in each of the major centres of Islamic culture.[516] They give values for each degree of solar/stellar altitude and each degree of solar longitude; they are necessarily latitude-specific, and they contain between 10,000 entries for a single function and 30,000 entries for time since sunrise or remaining till sunset (الدائر, *al-dā'ir*), hour-angle (فضل الدائر, *faḍl al-dā'ir*), and azimuth (السمت, *al-samt*).

Tables for the times of prayer

The times of the five daily prayers in Islam are defined relative to the position of the sun over the local horizon:

- المغرب, *al-maghrib*, at sunset
- العشاء, *al-ʿishā'*, at nightfall
- الفجر, *al-fajr*, at daybreak
- الظهر, *al-ẓuhr*, after midday, sometimes defined by shadow increase over midday minimum

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516 All such tables are analyzed in King, *In Synchrony with the Heavens*, vol. 1 (2004), I: 1-190, and II: 191-456. For an overview see the article "Mīḳāt (astronomical timekeeping and the regulation of the times of prayer)", in *Enc. Islam*, 2nd edn.

For a look at these materials from the point of view of a historian of Islamic law, see Quadri, "Variant approaches to astronomical knowledge in Islamic legal texts" (2019).

- العصر, *al-ʿaṣr*, mid-afternoon, beginning and end defined by shadow increases over midday minimum

Sets of prayer-tables were prepared in the 9th century and then all over the Muslim world, still in the medieval tradition, until the 19th century.[517] They usually include a table (called شبكة , *shabaka*) of the solar longitude for each day of a four-year solar calendar period. They tend to contain values for each degree of solar longitude (طول الشمس, *ṭul al-shams*) of the following functions (here taken from the Damascus corpus):

- the solar meridian altitude (غاية الارتفاع, *ghāyat al-irtifāʿ*)
- half the diurnal arc (نصف قوس النهار, *niṣf qaws al-nahār*)
- the number of hours of daylight (ساعات النهار, *sāʿāt al-nahār*)
- the solar altitude at the beginning of the *ʿaṣr* (ارتفاع العصر, *irtifāʿ al-ʿaṣr*)
- the hour-angle at the beginning of the *ʿaṣr* (دائر العصر, *dā'ir al-ʿaṣr*)
- the time between the beginning of the *ʿaṣr* and sunset (ما بين العصر والغروب, *mā bayn al-ʿaṣr wa-'l-ghurūb*)
- the time between midday and the end of the *ʿaṣr* (ما بين الظهر واخر وقت العصر, *mā bayn al-ẓuhr wa-ākhir waqt al-ʿaṣr*)
- the duration of night (قوس الليل بكماله, *qaws al-layl bi-kamālih*)
- the duration of evening twilight (حصة الشفق, *ḥiṣṣat al-shafaq*)
- the duration of darkness (ما بين الشفق والفجر, *mā bayn al-shafaq wa-'l-fajr*)
- the duration of morning twilight (حصة الفجر, *ḥiṣṣat al-fajr*)
- the time remaining until midday when the sun in the azimuth of the *qibla* (الباقي للزوال حين تسامت الشمس القبلة, *al-bāqī li-'l-zawāl ḥīna tusāmit al-shams al-qibla*)

The last of these table-headings relates to finding the *qibla* or direction of Mecca, by means of the sun. Other corpuses of such tables, such as that

517 See the previous note.

for Cairo, include tables of the altitude of the sun when it is in the azimuth of the *qibla*.

With such tables, any *muwaqqit* or mosque astronomer worth his salt could advise the muezzin when to pronounce the calls to prayer. He might be also using also a sundial or quadrant by day, or, by day or by night, an astrolabe – see below.

Tables for finding the *qibla* as a function of longitude and latitude

The last category of tables that concern us present values of the *qibla* for each degree of longitude difference and latitude difference from Mecca. The earliest such tables, based on approximate formulae, date from 9th-century Baghdad and were called الجدول العشريني, *al-jadwal al-ʿishrīnī*, "20x20 table", with 400 entries serving 1° to 20° of each argument. Later, more extensive tables, such as that by the 14th-century Damascus *muwaqqit* al-Khalīlī, are based on an exact formula and contain close to 3,000 entries, mainly accurately computed.[518] Alas, we have no information on whether these tables were ever used.

Tables displaying the *qibla* for numerous localities

From the 9th century onward Muslim astronomers compiled tables of the longitudes and latitudes of dozens, sometimes hundreds of localities from the furthest Maghrib to China and from the Volga to the Yemen.[519] The vast majority of these do not display the *qibla*, but there are two major

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518 See King, "The earliest Islamic mathematical methods and tables for finding the direction of Mecca" (1986), and "al-Khalīlī's qibla table" (1975), also *Synchrony*, vol. 1 (2004), pp. 386-393.

519 The data in these tables – some 14,000 entries – from some 80 geographical and astronomical texts are gathered in Kennedy & Kennedy, *Islamic Geographical Coordinates* (1987). The data are arranged by place-name, increasing longitude, increasing latitude, and source.

exceptions.[520] First, the geographical table of al-Khāzinī (*fl*. Marw *ca*. 1125) has coordinates and *qibla*-values for about 250 localities, but computationally the values are not brilliant. Secondly, a monumental table compiled anonymously, probably in Kish, near Samarqand, *ca*. 1425: this contains about 275 entries and, in addition to the *qibla*-values in degrees and minutes for each locality, also the distance to Mecca for each locality, expressed in degrees and minutes, and also converted to *farsakh*s. The majority of values for both functions are accurately computed to the nearest degree.

Likewise, some Egyptian geographical tables from the 13th century onwards gave longitudes and latitudes and also *qibla*-values for hundreds of cities, and smaller lists are known from the 14th century for localities in Syria and Palestine, and from the 16th century for localities in the Ottoman Empire.

On sexagesimal notation and medieval trigonometric functions

Muslim astronomers, following their Greek predecessors, used numbers to base 60, which we (and they) call sexagesimal (ستيني, *sittīnī*, from ستين, *sittīn*, sixty).[521] They also used an alphanumerical notation called ابجد, *abjad* (literally, *a*,*b*,*c*,*d*) to represent these sexagesimal numbers. Separate letters were used for 1-10; 10, 20, ... 90; and 100, 200, 300, *etc*. Thus the ligatures كج ل يز, *kj l yz*, stand for 20+3 30 10+7, that is, 23 30 17. The modern convention for representing numbers to base 60, as were used in astronomy in Antiquity and throughout the Middle Ages, is as follows:

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520 The tables mentioned in this section are published in King, *World-Maps for finding the direction and distance to Mecca* (1999), pp. 71-89, 149-161 & 455-622.

521 On the notation see Kennedy, "Islamic astronomical tables" (1956/1990), p. 17; Berggren, *Episodes in the Mathematics of medieval Islam* (1986), pp. 39-48; and King, *In Synchrony with the Heavens*, vol. 1 (2004), p. 24. See also Irani, "Arabic numeral forms" (1955).

$$23;30,17° = 23 + 30/60 + 17/(60)^2, \text{ that is, } 23°30'17''.$$

Medieval trigonometric functions were to base 60, the radius of a base circle, which we denote by capitals.[522] Thus, for example: Sin x = 60 sin x. The arguments are arcs on the base circle, not angles. The values of the Sines (جيب, *jayb*) are expressed sexagesimally (to base 60). Shadow functions (ظل, *ẓill*), equivalent to our cotangents and tangents, are usually to other bases, such as 7 or 12.

On solar longitude, declination and rising amplitude, and solar altitude

A few remarks may be in order regarding the apparent behaviour of our own star, the sun – see **Pl. T2**. The apparent daily motion of the heavens is perpendicular to the celestial axis on a day-circle parallel to the celestial equator. The altitude of the celestial pole is a measure the latitude of the locality عرض البلد . We represent the apparent path of the sun across the sky on the longest day of the year (summer solstice), the shortest day of the year (winter solstice), and the day when daylight and night-time are the same (spring and autumnal equinoxes). The sun itself appears to move 360° on the ecliptic (not shown in the figure) in about 365¼ days from the vernal equinox to the summer solstice to the autumnal equinox back to the vernal equinox: its position on the ecliptic is called longitude طول الشمس . The distance between the solar day-circles at the solstices and that at the equinoxes, which is the celestial equator, is called the declination ميل الشمس . At the solstices it reaches its maximum الميل الاعظم of about 23½° north in summer and south in winter. The solar rising point on the horizon, or solar rising amplitude, at winter solstice مشرق الشتاء or مشرق الجدي is of prime importance for this study; it depends on the local latitude. For Cairo it is at about 27½° south of east.

522 Kennedy, "Islamic astronomical tables" (1956/1990), pp. 17-18; Berggren, *Episodes in the Mathematics of Medieval Islam* (1986), pp. 132-135; King, *In Synchrony with the Heavens*, vol. 1 (2004), pp. 24-25.

Medieval astronomers included in their handbooks tables of the solar longitude as functions of the date in the solar calendar, and tables of such basic functions as the solar declination and, less frequently, the solar rising amplitude, both as functions of the solar longitude.

For the astronomers, the time of day could be measured from sunrise الدائر or with respect to midday فضل الدائر . On a given day of the year at a given latitude, when the solar altitude was measured, the time of day was a function of the solar altitude. Muslim astronomers, beginning with Ibn Yūnus, tabulated for a specific latitude the functions such as time since sunrise, time remaining till midday, as well as the azimuth of the sun سمت الشمس, that is, its direction on the horizon.

The procedures adopted by the Muslim astronomers were of course equivalent to modern procedures, even if they appear at first sight more complicated.[523]

Methods of finding the *qibla*

The legal scholars and the specialists on folk astronomy developed their own ways of facing the Kaʿba using astronomical alignments. They developed a set of schemes for finding the *qibla* without any calculation. The astronomers, after the middle of the 8th century, began calculating the direction of the *qibla* using (medieval) geographical coordinates and mathematical procedures, either trigonometric or geometric or rule-of-

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[523] The reader can follow the admittedly complicated discussions of Ibn Yūnus in my *Astronomical works of Ibn Yūnus* (1972). See, for example, Ch. 10 (pp. 77-89) on the Sine function; Ch. 11 (pp. 90-110) on the Cotangent function; Ch. 15.3 (pp. 146-152) on time from solar altitude; Ch. 16 (pp. 159-161) on the duration of twilight; Ch. 18 (pp. 166-175) on the solar rising amplitude; and Ch. 20 (pp. 182-193) on the solar azimuth.

For a modern discussion of the derivation of medieval formulae by essentially medieval procedures, admittedly also complicated, see King, *In Synchrony with the Heavens*, vol. 1 (2004), pp. 23-42.

thumb. They prepared lists of *qibla*s of hundreds of localities between al-Andalus and China, and even highly sophisticated cartographic grids with which one could find the *qibla* for the whole world without any calculation at all. All of these *qibla*-values were based on medieval longitudes and latitudes, which were, of course, less accurate than the modern ones.

It is important to keep in mind that the *qibla*s proposed by the Muslim legal scholars would be different from those proposed by the Muslim astronomers. Both sets would necessarily different from modern *qibla* values, which are based on modern geographical coordinates. Therefore, when investigating the orientation of a historical mosque one must remain aware that there were different (now well documented) methods for finding the *qibla*, and it would be foolish to expect any historical mosque to be oriented in the modern *qibla*, unless by coincidence.

Earlier this year (2019) I published for the first time a list of the known medieval sources for Islamic sacred geography, the notion of the world divided in sectors about the Kaʿba with the *qibla* of each sector defined in terms of astronomical phenomena.[524] These sources, some 50 in number, had never been identified together before, although some examples known from geographical works were known decades ago but without a context, and others were introduced in 1987 in the article "Makka. As centre of the world" in the *Encyclopedia of Islam*. They were rediscovered mainly in previously-unstudied medieval Arabic scientific manuscripts in libraries around the world. Many more manuscripts of works on astronomy, folk astronomy, geography, sacred law, and encyclopedias, were searched for such materials with negative results. On the other hand, there are surely many more such sources that have not yet been located in manuscript libraries and many more that have disappeared without a trace.

(The death of spherical astronomy)

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[524] King, "Finding the *qibla* by the sun and stars" (2019), in which some 50 sources are listed.

These few paragraphs are dedicated to Ken Westphal, Istanbul, in gratitude for our conversations.

Historians of Islamic architecture are not alone in ignoring a significant (the most significant?) feature of the architecture that they study. We have scholars who write whole books or contribute to whole books on Islamic astronomy with barely a mention of spherical astronomy, the study of the apparent daily rotation of the celestial sphere, and thus of astronomical timekeeping. By this I mean the mathematical and practical use of the sun by day and the stars (and even the moon) by night for measuring time in general and the times of the five daily prayers in particular. What also gets neglected are the instruments that were used for these purposes: the astrolabes found in abundance in the world's major museums; the quadrants that were more widely used than the astrolabe at least in later centuries; and the few serious sundials that survive out of those which once upon a time featured in every major mosque.

Now it happens that spherical astronomy was of considerable importance in Islamic astronomy, but given the general lack of interest of historians of astronomy nowadays in spherical astronomy, that aspect is invariably ignored nowadays, not least by historians of Islamic astronomy interested only in planetary models. And not only in Islamic astronomy: there is, as far as I know, no serious documentation and investigation of pre-modern European tables for astronomical timekeeping, which, of course, served the same purpose as the Islamic ones I have described in *In Synchrony with the Heavens*. People write books about "time" in Muslim and Christian cultures and mention neither the tables nor the instruments that were available for time-keeping. (Whether or not these devices were used is another matter.) People who write about the institution of prayer in Islam never pose any questions about the very strange definitions of the times of the day-time prayers in Islam, which actually guard the secret about the development of the institution of prayer in Islam. It's not all about the *number* of prayers (five), it's about the *times* of the prayers, whose times, defined in terms of shadow increases over the midday minimum, can be explained by reference to a simple approximate Indian formula linking shadow increases to the seasonal hours. It's also about the

names of the prayers, which are related the names of the corresponding hours in Arabic.

In New York in the early 1980s I had undergraduates from a "History of Science" class ask people on Washington Square: "On which day or days of the year is the sun directly overhead in New York?" The answers varied from "Every day" to "Never" with some interesting suggestions in between. Even astrophysicists don't need spherical astronomy any more. In the 1990s I gave a lecture on Islamic astronomy to some 20 graduate students in astrophysics and found to my surprise that not a single one of them knew how to find the local latitude!

One of my teachers (by osmosis) at Yale University was the Danish scholar Asger Aaboe (1922-2007), who, in addition to many scholarly papers on Babylonian astronomy, published introductions to the history of early Babylonian and Greek mathematics and astronomy. These were arranged in the form of historical "episodes" which some believe is the only way to teach the history of science.[525] Chapter 0 in the latter book is entitled "What every young person ought to know about naked-eye astronomy". This appropriately begins with spherical astronomy and then turns to planetary astronomy. In his introduction Asger records questions and answers on problems on spherical astronomy he posed years before to some secondary school students of mathematics, the memory of which encounter inspired him to write the book. "Does the sun rise and set?" "Yes." "Does the moon rise and set?" "Yes." "Do the stars rise and set?" And that is where the fun begins.

The people who write books on timekeeping in medieval Islamic civilization with barely a mention of the astronomical tables that were used by every *muwaqqit* also ignore sundials that were in every significant mosque. Or they claim that Muslims used the astrolabe to regulate their

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525 Aaboe, *Episodes from the Early History of Mathematics* (1964), and *Episodes from the Early History of Astronomy* (2001), esp. pp. 1-23 for Chapter 0. For an obituary see Asger H. Aaboe (1922-2007)", in *ISIS* 98 (2007): 796-798.

daily activities. Or they just write to explore the "political, social and cultural modalities of time in the Ottoman Empire", without being aware of the tables and instruments that were, with the *zīj*es and ephemerides, the main tools of the Ottoman astronomers.[526] And now we have non-specialists writing "global history" by trying to put Islamic astronomy in a place where they feel at home, such as the "Persianate world" of the so-called "Silk Road".[527] But inevitably there is far worse on the internet.

The regional schools of astronomy

> "Decline seems to be the wrong word to describe the production of reliable and useful knowledge in early modern Islam. Even the notion of stagnation misses the point that slow advances occurred in different parts of Islamdom, notably the Balkans, Anatolia, the Volga basin, Iran, and North India. The absence of the Arab world from this list underscores the predominance of areas using Persian and Turkish as vehicular languages. As indigenous innovation lost momentum towards 1600, Muslims compensated by demonstrating a growing openness to the findings of infidel scientists and technical experts. The obligation of monarchs to act in the public interest enabled rulers to stimulate this process. In the Ottoman and Mughal cases there was an almost seamless transition, whereas other parts of Islamdom witnessed a marked trough between the impasse reached by classical knowledge and the adoption of European ideas. The slow tempo of Islamic innovation mattered tremendously, because the West was sprinting ahead so fast. Although Muslim elites began to emulate Europe seriously from the eighteenth century, they failed

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526 Georgeon & Hitzel, eds., *Les Ottomans et le temps* (2011).

527 Lohlker, "Global history: Understanding Islamic astronomy" (2019), published in a Silk Road journal out of Korea. Alas the author has very little control over the history of Islamic astronomy. That subject becomes "global" only when considered in the light of other astronomical traditions, as shown by Christopher Walker, ed., *Astronomy before the telescope* (1996), and Clive Ruggles, ed., *Handbook of Archaeoastronomy and Ethnoastronomy* (2015). But everybody likes the Silk Road.

> to achieve an Industrial Revolution. This allowed de jure infidel tutelage to spread across most of the 'abode of Islam' in the course of the nineteenth century, with de facto control exercised in nominally independent states. Nevertheless, the characterisation of the centuries prior to c.1850 as a scientific and technological 'dark age' has had perverse effects. Rather than situating themselves in the line of a rejuvenated indigenous tradition, Muslim scientists and managers have tended to cut themselves off from their own roots, embracing Western modernity as a total package. A recognition of Islamic strengths in the early modern production of reliable and useful knowledge might help to bridge the destabilising psychological gulf between the old and the new, the effects of which remain with us to this day." William Gervase Clarence-Smith, "Scientific and technological interchanges between the Islamic world and Europe, c. 1450-c. 1800" (2007), pp. 26-27.

During the 9th and 10th centuries the new Islamic astronomy spread out of al-ʿIrāq and Iran to the provinces, including, to the west, Syria, Egypt, the Yemen, the Maghrib and al-Andalus. (The eastern regions of Iran, Afghanistan and Central Asia do not concern us here.) From the 11th century onwards, regional schools of astronomy developed in each these areas with their own interests and authorities, a situation which persisted until the 19th century.[528] Modern attempts to treat "Islamic astronomy"

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528 On the available bibliography on these regional schools from al-Andalus and al-Maghrib to India see King & Samsó & Goldstein, "Astronomical handbooks and tables from the Islamic world" (2001), pp. 15-17.

I am particularly sensitive about the regional tradition of astronomy in the Yemen, which lasted 1,000 years, and is important not least for our understanding of the Egyptian tradition. The preliminary draft of my first book, *Mathematical astronomy in medieval Yemen* (1983), was written in quarantine at Cairo Airport, where I landed after a flight from Sanaa, delayed in Medina by a sand-storm. Over 100 Yemeni manuscripts were documented almost 50 years ago, some of works compiled by Rasulid Sultans themselves. This proves, amongst other things, that some good things can come from quarantine.

ignoring these regional traditions, and also "practical astronomy", miss the point.

Islamic astronomy declined because all of the problems had been solved, some many times over. But the decline was of a different nature and took place at different rates in each of the various major regions. For Egypt, we have the leading astronomer in the Muslim world working in Cairo *ca*. 1000 and numerous Egyptian astronomers still functioning seriously *ca*. 1800, none of whom caught the attention of any Egyptian historian or any French or British visitors to Egypt. Modern attempts to discuss the decline of Islamic science without distinguishing between regional developments are doomed. The above quote from a non-technical overview "Scientific and technological interchanges between the Islamic world and Europe, c. 1450-c. 1800" (2007) by the British orientalist William Gervase Clarence-Smith is an exception to the general trend.

We shall be dealing with the regional school based in Cairo – **Ch. 13**. Further, I must beg the reader's indulgence for concentrating on astronomical tables and practical astronomy in the service of Islam, but the main item to be investigated in this **Part 1b** is a single table found in a corpus of tables for astronomical timekeeping which serve to regulate the times of prayer and establish the *qibla*, namely, a table for orienting the *bādahanj* – **Ch. 17**.

Finally, we shall not be talking about transmission, a favourite topic nowadays, sometimes called 'scientific exchange'. Medieval Europe

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Furthermore, my friend and colleague Daniel Varisco has published numerous works on folk astronomy and its connection with agriculture in medieval and modern Yemen, and my former doctoral student and current colleague Petra Schmidl has published a vast amount of material in medieval Yemeni treatises on the determination of the *qibla* and the organization of the prayer-times.

None of this is mentioned in Hollenberg & Rauch & Schmidtke, eds., *The Yemeni Manuscript Tradition* (2015). In the meantime, my own country is providing weapons for rogue coalitions bent on destroying the Yemen.

learned little from the Muslim world, when one considers what was available. But what they did learn was mainly from the Andalusī school, which was anyway largely out of touch with mainstream activity in Iraq Iran, Syria and Egypt. Nevertheless, the closer historians who are familiar with Islamic astronomy look at what the Europeans actually did in the Middle Ages, the more medieval European astronomy can be seen to be heavily inspired by the Islamic tradition. This is, however, not true for the Egyptian tradition, which remained unknown in medieval Europe, not least because it was unknown in al-Andalus.

What is missing in the history of Islamic astronomy

When I was a student of mathematics at Cambridge University in 1960-63, my favourite course was entitled "Mathematical Methods", given by Dr. Leon Mestel (1927-2017). It dealt with such delightful themes as algebraic and trigonometric series that could be generated by complex variables; solving partial differential equations; playing with hyberbolic trigonometric functions. At the time I appreciated the title of the course as well as its content and the lecturer. But over half a century later I still appreciate the title, even though I have forgotten the content and its presentation.

It is precisely in medieval "mathematical methods" that the Muslims excelled, that is:

- **complex sexagesimal arithmetic and 60x60- or 60x60x60-entry multiplication tables;**
- **plane trigonometry;**
- **six basic trigonometric functions;**
- **tabulating the sine and cotangent function for each minute of argument;**
- **spherical astronomy with tabulation of all manner of functions;**
- **universal solutions to problems of spherical astronomy for all latitudes;**
- **tabulation of universal auxiliary functions for solving problems of spherical astronomy for all latitudes;**

- analemma constructions to reduce three-dimensional problems on the celestial sphere to two-dimensions;
- spherical trigonometry;
- non-linear scales on instruments;
- construction on instruments of curves that are neither circular nor conic sections;
- tabulation of lunar and planetary equations with double-arguments that can be taken from mean-motion tables in order to facilitate the determination of lunar and planetary positions;
- tables for determining lunar crescent visibility;
- tables for the times of prayer for different or for all latitudes; and
- tables displaying the direction of Mecca (*qibla*); ... .

Obviously not every Muslim astronomer was involved with all of these topics. Nor, because Islamic astronomy was regional, would Muslim astronomers in different parts of the Muslim world necessarily have known about them. But I list these subjects here because they are barely ever mentioned in accounts of the history of Islamic astronomy, either by Western historians who should have access to the scholarly literature or by non-Western historians who, in the main, do not. This is practical astronomy, which is equally important in the history of astronomy as theoretical astronomy, especially in a society in which religious practice was linked to practical astronomy as in no other civilization in human history. Elsewhere in this monograph I stress the fact that in Islamic civilization astronomy functioned on two levels: folk astronomy, favoured by the scholars of sacred law, and mathematical astronomy, favoured by a select group of specialists. The reader will look in vain for historians of astronomy who are aware of this, let alone who mention it.

In the 1950s, Ted Kennedy discovered that the solar, lunar and planetary models of Ibn al-Shāṭir (Damascus *ca*. 1350) were the same as those of Copernicus (Poland *ca*. 1540), which raised several interesting questions. Since then a series of scholars, notably George Saliba and Jamil Ragep, have sought to find a link between the two

astronomers. More recently such a link, albeit putative, has been established between the polyglot Jewish astronomer, instrument-maker and medic from Istanbul, Mūsà Jālīnūs, who was familiar with the work of Ibn al-Shāṭir but also spent time at the University of Padua, as did Copernicus. Mūsà was the author of several remarkable treatises which have been studied only in the past few years, namely, by Y. Tzvi Langermann and Robert Morrison. All this has nothing to do with heliocentricity (which is all people care about), simply with geometrical models (which nobody cares about).[529] **In 2018 it was established that the elusive "Mūsà" who in 1480 signed the unique complete spherical astrolabe preserved in Oxford was none other than Mūsà Jālīnūs. It had not been previously noted that the horary markings served the latitude of Istanbul. So Mūsà has been with us for a long time without our knowing who he was.**[530]

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529 On the remarkable works of this Istanbul personality see Y. Tzvi Langermann, "A Compendium of Renaissance Science: *Ta'alumot hokma* by Moshe Galeano" (2007), and "Medicine, Mechanics, and Magic from Moses ben Judah Galeano's *Ta'alumot hokma*" (2009); Robert Morrison, "An Astronomical Treatise by Musa Jalınus alias Moses Galeano" (2011), and "A Scholarly Intermediary between the Ottoman Empire and Renaissance Europe" (2014), and "Musa Calınus' Treatise on the natures of medicines and their use" (2016).

530 Francis Maddison, "A fifteenth-century Islamic spherical astrolabe" (1962); and King, "Spherical astrolabes in circulation – From Baghdad to Toledo and to Tunis and Istanbul" (2018).

(13 — Excursus: Astronomy in Islamic Egypt)

“Egypt has no place in a work on the history of mathematical astronomy. Nevertheless, I devote a separate “Book” on this subject in order to draw the reader’s attention to its insignificance which cannot be too strongly emphasized in comparison with the Babylonian and the Greek contribution to the development of scientific astronomy.” Otto Neugebauer, *History of Ancient Mathematical Astronomy* (1975), II, p. 559.

“Historians often underestimate, while others frequently exaggerate the capabilities of the ancient Egyptians. The wider truth is that they were a practical people. The development of science and mathematics in Egypt, such as it was, lies rooted in that practicality.” Ronald A. Wells, “Astronomy in (Ancient) Egypt” in Christopher Walker, ed., *Astronomy before the Telescope* (1996), p. 26.

“Do you think anyone ever hears about this (excavation site of ours at Fustat)?” (George Scanlon) asked, waving at the dig, a collection of deep holes and broken-brick foundations, blending with the surrounding rubble. “Oh, no. Because Fustat is an Islamic city. Because we have the greatest intellectual mental block ever. There is nothing worse than the Christian-Classical-Egyptology syndrome. In these parts, if it is not Greco-Roman, Pharaonic or Biblical, forget it.” ” The American Islamicist and archaeologist of Fustat, George Scanlon (1926-2014), quoted in Helen Gibson, “Out of the rubbish – An Arab capital”, *International Herald Tribune*, 19.11.1971. (My sentiments entirely.)

“She was the fabled queen of ancient Egypt, immortalised over thousands of years as a beautiful seductress. But, despite her fame, Cleopatra’s tomb is one of the great unsolved mysteries.” Dalya Alberge, “‘Sensational’ Egypt find offers clues in hunt for

Cleopatra's tomb", *The Guardian* 12.07.2020. (So it continues ... .)

"Though their historians, including Maqrizi (died 1427), are rightly famous and their pious foundations are splendid, **(the Mamluks) appear to have had no interest in any science save geography** (al-'Umari died 1345). And though they saw themselves as primarily Turks, there was no period in which an Islamic dynasty can be more properly described as Egyptian." J. Michael Rogers, *The Spread of Islam* (1976), p. 41 (my emphasis).

"Who are the Mamluks? Eskimos?", editor-reviewer of my 1983 paper "Astronomy of the Mamluks".

The leading historian of ancient Near Eastern mathematical astronomy in the 20th century, Otto Neugebauer (1899-1990), included in his monumental *History of Ancient Astronomy* (1975) a separate 'Book' on (Ancient) Egypt. His opening sentence is quoted above. He wrote this after he and Richard Parker had published four volumes of *Egyptian astronomical texts* (1969) so he knew a great deal about Ancient Egyptian astronomy. Decades of research by ethno-astronomers and archaeo-astronomers have not proved this appraisal unjustified as far as mathematical astronomy is concerned. (I refer here to sophisticated mathematical astronomy as we know it from the Babylonians and Greeks, bearing in mind that for some colleagues in Classical Studies it is disturbing to have to acknowledge that the Greeks owed much to the Babylonians). On the other hand, non-mathematical or folk astronomy there was in Ancient Egypt, and that is now also documented in writings on archaeoastronomy.[531] Indeed, there is plenty of material available to fill a book on the history of Ancient Egyptian astronomy[532] rather than a

[531] See, for a start, the chapter "Astronomy in (Ancient) Egypt", by Ronald A. Wells in Walker, ed., *Astronomy before the Telescope* (1996), and the imposing volume *Handbook of Archeoastronomy* (2015), edited by Clive Ruggles.

[532] For example, Franci, *Astronomia egiziana* (2010).

superfluous empty chapter, but it has nothing to do with serious observations or calculations. There is, however, more to the history of astronomy than observations and calculations.

The Hellenistic tradition of mathematical astronomy in Hellenistic Egypt is essentially independent of the Ancient Egyptian tradition. Also, as far as we know, nothing in medieval Egyptian astronomy was derived from Ancient Egyptian astronomy, with the exception of some mythological material of no scientific consequence.[533]

Astronomy in Islamic Egypt is seldom mentioned anywhere. The topic gets very poor coverage on the internet. The statement cited above of the American scholar of Islamic art and architecture George Scanlon (1926-2014), who directed a long-term project to excavate the ruins of Fustat, to the effect that the Islamic heritage of Egypt always comes last, is most apt. This claim is as relevant in the history of science as it is in archaeology. The discovery of a Ancient Egyptian sarcophagus decorated with the image of a crescent moon will attract more attention than a medieval Islamic Egyptian astronomical handbook of hundreds of pages of tables; or a medieval Egyptian astrolabe with inscriptions in Arabic and Coptic; or an Egyptian Arabic treatise with a hundred illustrations of astronomical instruments mostly unknown in medieval Europe; or a highly complex medieval Egyptian treatise on the use of the most sophisticated astrolabe ever made.[534]

For most readers the following account of astronomy in Islamic Egypt will be new, but it is only a brief summary of materials available in the scholarly literature. The enormous amount of non-mathematical materials

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533 Casanova, "De quelques légendes astronomiques Arabes" (1902).

534 Angy Essam, "Egypt amazes the world with 2019 archaeological discoveries", *egypt today* 30.12.2019, at www.egypttoday.com/Article/4/79177/Egypt-amazes-the-world-with-2019-archaeological-discoveries-P2. Egypt could amaze the world even more if someone would take the slightest interest in its medieval astronomical heritage.

– geographical, cartographical, and folk astronomical – discussed in two recent books by Emilie Savage-Smith and Youssof Rapoport on the "Book of Curiosities", an 11th(?)-century Arabic cosmographical work from Cairo, cannot be included here.[535] It does not deal with mathematical astronomy in Cairo, which is our principal concern here.

Centuries of astronomy in Fatimid, Ayyubid, Mamluk and Ottoman Egypt

The *Description de l'Égypte* contains two hints that there might just have been some astronomy practiced in medieval Egypt. First, the images of the fragments of a sophisticated marble sundial dated 1296/97 rescued from the Mosque of Ibn Ṭūlūn and second, the images of a medieval (Andalusī or Maghribī) astrolabe – **Pls. S10** & **S13**. Edward Lane's *Description of Egypt* contains not a word or image of this nature. The same author's *Manners & Customs* contains a single uninspired paragraph on the supposedly pathetic state of science in Egypt in his time – see below. Yet, as we shall see, around the year 1800 orientalists in Paris were working on manuscripts of an astronomical work in Arabic that was compiled in Cairo around the year 1000 and which was more sophisticated than any other known Islamic (or medieval European) astronomical work known to them. This was the monumental astronomical handbook prepared by the great astronomer Ibn Yūnus for the Fatimid Caliph al-Ḥākim.

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535 Savage-Smith & Rapoport, *An Eleventh-Century Egyptian Guide to the Universe* – The Book of Curiosities (2014), and *Lost Maps of the Caliphs* (2018). A date of between 1020 and 1050 is proposed for the original compilation, but it is very strange that there is, for example, no mention of Ibn Yūnus or Ibn al-Haytham. Also missing is any trace of sacred geography. The authors focus on al-Khwārizmī as a source for the geographical coordinates but already the Kennedys in their 1987 survey pointed out that Ibn Yūnus' geographical tables were based on those of al-Khwārizmī.

In the 1970s – the decade of the so-called "Festival of the World of Islam" in London – my distinguished art historian colleague, none other than J. Michael Rogers, wrote that the Mamluks had "no interest in any science".[536] **By 1970, however, it was obvious that Mamluk Cairo, especially in the 13th century, was one of the leading centres of astronomy in the world, and Mamluk Damascus in the 14th century was the leading centre of astronomy in the world, yes, the world. Around 1300 there was astronomical activity even in Jerusalem.**[537] It pays to look at the available historical sources – manuscripts and instruments in libraries and museums around the world – before inventing history that suits. Also, it is beyond the scope of this study to consider more than in passing the astronomical tradition in Syria, which was, of course, closely related to that in Egypt, and which is somewhat better known.[538]

We shall see below that there was a vibrant tradition of astronomy in Egypt throughout the medieval period; this we know thanks to their surviving treatises and instruments. Also, it was in Cairo that the office of the

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536 The inclusion of an unusual world-map with a curious coordinate grid in the encyclopaedia of al-ʿUmarī led others to falsely claim that it was the "lost" world-map of the early-9th-century Abbasid Caliph al-Ma'mūn (which had an orthogonal grid): see King, *World-maps* (1999), pp. 31, 33, 34.

On a remarkable recently-discovered Mamluk manuscript of a Fatimid treatise on geography and cartography see now Savage-Smith & Rapaport, *An Eleventh-Century Egyptian Guide to the Universe* – The Book of Curiosities (2014), to which we shall return.

537 See King, "Astronomy in medieval Jerusalem" (2018), at www.acade—*—mia.edu/37989849/. The first attempt to make sense of orientations in Jerusalem was in Walls & King, "The sundial on the West Wall of the Madrasa of Sultan Qaytbay in Jerusalem" (1979), p. 19, and p. 21, nn. 20-22.

538 See King, "L'astronomie en Syria à l'époque islamique" (1993) for a brief introduction, concentrating on instruments.

muwaqqit, or mosque astronomer, came into being.[539] But there is more: My friend and former doctoral student from Québec, François Charette, has shown us what these astronomers achieved in the way of sophisticated astronomical instrumentation. His work on al-Marrākushī, Najm al-Dīn al-Miṣrī, Ibn al-Sarrāj and Ibn al-Majdī is particularly meritorious.[540] The indefatigable German historian of Islamic science, my friend and colleague, Sonja Brentjes, has brought some of the Mamluk astronomers back to life again by consulting biographical works on them.[541] In addition, she has documented the teaching of astronomy and geometry in Ayyubid and Fatimid Egypt and Syria, numerous accounts of astrological "situations" (in which events did not quite turn out as the astronomers/astrologers predicted).[542] I shall not attempt to survey these materials here.

Mathematical astronomy

If there was serious astronomical activity in Muslim Egypt before the late 10th century, we have but little information on it. None of the observations recorded by Ibn Yūnus, apart from his own, were made in Egypt. Astronomical knowledge would have come from Baghdad but also from

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539 See King, "Fatimid astronomy" (1999), "Mamluk astronomy" (1983), "On the role of the muezzin and *muwaqqit*" (1996), "Mamluk astronomy and the institution of the *muwaqqit*" (1996), and also the next notes.

540 Charette, *Mathematical instrumentation in 14th-century Egypt & Syria* (2003) on Najm al-Dīn al-Miṣrī's remarkble treatise on 100 instrument types known to him. A survey of instrumentation in Mamluk Egypt is *ibid*., pp. 5-31. See also Charette's articles on al-Marrākushī, Ibn al-Sarrāj and Ibn al-Majdī in *BEA*.

541 Brentjes, "Shams al-Dīn al-Sakhāwī on muwaqqits, mu'adhdhins, and the teachers of various astronomical disciplines in Mamluk cities in the 15th Century" (2008).

542 Brentjes, "On four sciences and their audiences in Ayyubid and Mamluk societies" (2017).

Kairouan (Tunisia), whence the Fatimid dynasty hailed and where in the 9th century there were already active Muslim and Jewish astronomers.

I shall refrain from venturing into uncharted waters such as the alleged astrological influence in the foundation of Cairo in 969;[543] the Jewish astrologer Paltiel ben Hasadi appointed by the Caliph al-Muʿizz;[544] the astronomical background of Ibn al-Haytham[545] and the medic and astrologer Ibn Riḍwān.[546] These are important topics but are not relevant to our present investigation.

Ibn Yūnus and the *Ḥākimī Zīj*

The astronomer Ibn Yūnus (d. 1009), who worked for the Fatimid Caliphs and al-Ḥākim, was one of the leading astronomers of medieval Islamic civilization and without a doubt the greatest astronomer of medieval Egypt.[547] He was heir to the new tradition of Islamic mathematical

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543 Creswell, *The Muslim Architecture of Egypt*, vol. 1 (1952), pp. 19-23, on the sources (currently not available to me); Raymond, *Cairo* (2000), pp. 27, 35, 37; Nicolle, *Saracen strongholds AD 630-1050* (2008), pp. 37-38; Bloom, "Ceremonial and sacred space in Early Fatimid Cairo" (2007), p. 99 ("an amusing story ... , but the fact that much the same story has been told earlier about Alexander's foundation of Alexandria much reduces its evidential value and shows it to be a topos"); Campion, "Archaeoastronomy and calendar cities" (2016), p. 5. The sources might deserve a closer look.

544 Dubnov, *History of the Jews ... ...,* vol. 2, 1968 edn., p. 588.

545 Article "Ibn al-Haytham", by Abdelrahim I. Sabra, who devoted much of his life to editing and translating Ibn al-Haytham's *Optics*. Various medieval accounts of his personal history between Basra and Cairo are presented, but the context of his astronomical writings – cosmology, *qibla* – remains obscure. A recent overview by a non-specialist is in McQuaid, "Ibn al-Haytham" (2019).

546 See, for example, the article "Ibn Riḍwān" in *DSB* by Roger Arnaldez, and Goldstein, "Evidence for a Supernova of A.D. 1006" (1965).

547 On Ibn Yūnus see my articles in the *DSB* and *BEA* (reduced). The fullest treatment of his activities and relationship with the Caliphs al-ʿAzīz and al-Ḥākim is

astronomy that had developed in Baghdad and he made significant contributions himself. He worked in an academic milieu that was rich in books and potential funding.[548]

Ibn Yūnus came from a well-known family of specialists in the Prophetic traditions. His great-grandfather Yūnus had been a companion of the famous legal scholar al-Shāfiʿī. His father died in 958, so the son was probably a young man in 969 when Cairo was built. From 977 to 996, which corresponds roughly to the reign of the Caliph al-ʿAzīz, Ibn Yūnus made astronomical observations, for which we have his reports. These were renewed by order of the Caliph al-Ḥākim, who in 996 at the age of 11 succeeded al-ʿAzīz.

Our astronomer was something of an eccentric. He used to wrap his turban round his high-peaked cap and then place his cloak over his turban. When he rode his donkey people used to laugh at him because he was so well known and so badly dressed in shabby clothes. On one occasion he went to the Muqaṭṭam hills overlooking Cairo with another astronomer Abu ʻl-Ḥasan al-Ṭabarānī and observed Venus for a long time. Then Ibn Yūnus took off his cloak and turban, put on a woman's red cloak and red veil, and took out a lute, an instrument which he played well. Then he played on, with incense burning in front of him. al-Ḥākim himself reported that

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in Aydın Sayılı's excellent book *The Observatory in Islam* (1960), pp. 130-156. On the spherical astronomy in his major work see King, *The astronomical works of Ibn Yūnus* (1972), in which the biographical details are recorded on pp. 3-6. For manuscripts of his works see Sezgin, *Geschichte des arabischen Schrifttums* V, pp. 342-343; VI, pp. 228-231, & VII, p. 173 (all somewhat confused) and the *DSB* article cited above, as well as *Cairo Survey* (1986), B59.

On the lives of the two Fatimid caliphs see the articles "al-ʿAzīz al bi'llāh" by "al-Ḥākim bi-amr Allāh", both by the French orientalist and historian Marius Canard (1888-1982), in *Enc. Islam*, 2nd edn., also Farhad Daftary, "al-Hakim bi-Amr Allah", in *Encyclopedia of Ismaili Studies*. See further numerous writings by Paul E. Walker.

[548] For the cultural milieu see Paul Walker, "Fatimid institutions of learning" (1997), esp. pp. 193-199 on libraries and observatories.

Ibn Yūnus came to one of his sessions carrying a heavy pair of shoes (which normally should have been left outside). He kissed the ground and sat down with the shoes at his side. When the astronomer wanted to leave, he kissed the ground, took his shoes and put them on, and then left. Even the eccentric al-Ḥākim found this strange.

Ibn Yūnus was famed for his abilities in astrological predictions. One day when he was in good health, he predicted that he would die in seven days' time. He whitewashed the hallway of his house in Fustat and locked himself in, washed the ink from some of his manuscripts, and died on the seventh day.

Ibn Yūnus' major work was a monumental astronomical handbook with tables calledالزيج الحاكمي الكبير , *al-Zīj al-Ḥākimī al-kabīr*, the adjective *kabīr*, large, denoting that it was very large, and also that he compiled at least one smaller *zīj* .About three-quarters of the enormous work are still extant in substantial manuscript fragments preserved in Leiden and Oxford and Paris – **Pl. S2**. Fragments of the smaller work have survived in various Yemeni *zīj*es and in a manuscript iin Timbuktu. A remarkable miniature in a 16th-century Egyptian treatise on astrology shows Ibn Yūnus handing a copy of his major *Zīj* to the Caliph – **Pl. S1**.[549] This work was used not only in Egypt but it was also influential in Iran and especially in the Yemen.

The extraordinary and unique list of some 100 lunar and planetary observations reported by Ibn Yūnus in the Leiden manuscript caught the attention of the Dutch orientalists over 300 years ago. The observations were partly made in Baghdad by his predecessors and partly by himself in Cairo-Fustat. But it was the French orientalist Armand-Pierre Caussin de Perceval (1795-1871) who in 1804 published the entire section on

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[549] King, "Aspects of Fatimid astronomy" (1999), p. 498, and "An illustration of the Caliph al-Ḥākim together with his astronomer/astrologer Ibn Yūnus" (2010).

observations, in Arabic with a French translation, much to the satisfaction of later astronomers using historical data of this kind (my translation).[550]

The observations described by Ibn Yūnus are of conjunctions of planets with each other and with Regulus (α Leonis, a star conveniently very close to the ecliptic), solar and lunar eclipses, and equinoxes; he also records measurements of the obliquity of the ecliptic (chapter 11) and of the maximum lunar latitude (chapter 38). All of these accounts are notable for their lack of information on observational procedures. The following passage is a translation of one of Ibn Yūnus' accounts of a planetary conjunction that he had observed:

> "A conjunction of Venus and Mercury in Gemini, observed in the western sky: The two planets were in conjunction after sunset on the night whose morning was Monday, the 13th day of Jumādā II, 390 Hijra era. The time was approximately eight equinoctial hours after midday on Sunday, which was the 5th day of Khardādh, 369 Yazdigird era. Mercury was north of Venus and their latitude difference was a third of a degree. According to the *Mumtaḥan Zīj*, their longitude difference was four and a half degrees." (Caussin, p. 217.)

The Sunday mentioned was 19 May 1000, and computation with modern tables confirms that there was a conjunction in longitude that evening and that Mercury was indeed one-third degree north of Venus. About 40 such planetary conjunctions observed by Ibn Yūnus are described in the *Zīj*.

The following passage is a translation of Ibn Yūnus' account of the lunar eclipse that occurred on 22 April 981 (Oppolzer no. 3379) (my translation):

> "This lunar eclipse was in the month of Shawwāl, 370 Hijra era, on the night whose morning was Friday, the 3rd day of Urdībihisht, 350 Yazdigird era. We gathered to observe this eclipse at al-Qarāfa, in the

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[550] Caussin de Perceval, "Le livre de la grande table Hakémite" (1804), contains Arabic text and French translation of the introduction and all of the observation reports.

Mosque of Ibn Naṣr al-Maghribī. We perceived first contact when the altitude of the moon was approximately 21 degrees. About a quarter of the lunar diameter was eclipsed, and reemergence occurred about a quarter of an hour before sunrise." (Caussin, p. 187.)

Some of the thirty eclipses reported by Ibn Yūnus were used by the Canadian-American astronomer and mathematician Simon Newcomb (1835-1909) in his determination of the secular acceleration of the moon. More recently, other observations recorded in the *Ḥākimī Zīj* have been used by the American physicist and astronomer Robert Russell Newton (1918-1991).[551] In our time, numerous publications on medieval Islamic observations have been published by the British astronomer F. Robert Stephenson (b. 1941) and his colleagues at Durham University.[552]

Other parts of the *Ḥākimī Zīj* were recognized as important too. The Sédillots, father and son, Jean-Jacques (1777-1832) and Louis-Amélie (1808-1876) made substantial contributions to the history of astronomy in medieval Egypt (see further below on al-Marrākushī).[553] The father made a partial translation into French (alas, now lost) of 47 chapters of the *Ḥākimī Zīj* from the Leiden and Paris manuscripts, and it was from this that the celebrated French historian of astronomy Jean-Baptiste Delambre (1749-1822) was able to write extensively on the spherical astronomy in the *Zīj* in his *Histoire de l'astronomie du moyen âge* (1819). From this the German historian of mathematics Anton von Braunmühl (1853-1908) was

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551 Newcomb, "Researches on the Motion of the Moon" (1878), and Newton, *Ancient astronomical observations and the acceleration of the Earth and Moon*, (1970).

552 For example, see his *Historical eclipses and Earth's rotation* (1997), esp. pp. 468-488. See further www.dur.ac.uk/physics/staff/profiles/?id=2771.

553 On the activities relating to the history of Islamic astronomy and mathematics by scholars in Paris from the late 18th century through the early 19th century, particularly those of L.-A. Sédillot and F. Woepcke, see Charette, *Orientalisme et histoire des sciences* (1995/2003).

able to include Ibn Yūnus in his published lectures on the history of trigonometry (1900/03).[554] This activity motivated the German historian of Islamic mathematics and astronomy Carl Schoy (1877-1925) to work on some remarkable chapters in the previously-unstudied Oxford manuscript of the *Zīj*,[555] but his untimely death shortly after accepting a teaching position at Frankfurt University marked an end of original research on Ibn Yūnus. Nobody did any research on the history of Islamic astronomy in Egypt after Schoy's time for 50 years ... ...

... ... until the day in 1970 at Yale University when Professor Bernard Goldstein suggested to me for my doctoral dissertation to "look at Ibn Yūnus", by which he meant "redo Delambre and Caussin". Clearly, I had to order microfilms of the Leiden, Oxford and Paris manuscripts, as well as one in the Chester Beatty Library in Dublin, which the English Arabist Arthur John Arberry (1905-1969) had recently catalogued as (a previously-unknown) copy of the *Zīj* of Ibn Yūnus. The Dublin manuscript was in fact a copy of the Cairo corpus of tables for timekeeping by the sun and regulating the times of Muslim prayer, which, for the history of Islamic astronomy, presented the opportunity to enjoy a new beginning. No such tables had been known previously.

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[554] von Braunmühl, "Beiträge zur Geschichte der Trigonometrie" (1898), pp. 24-27, and *Vorlesungen zur Geschichte der Trigonometrie* (1900/03), I, pp. 61-65.

[555] Carl Schoy, *Beiträge zur arabisch-islamischen Mathematik und Astronomie*, 2 vols., Frankfurt, 1988, contains reprints all of Schoy's writings on Ibn Yūnus. See also King, *The astronomical works of Ibn Yūnus* (1972), p. 13.

Schoy's contributions to the history of Islamic mathematics, astronomy and geography were appreciated way beyond the frontiers of Germany: see the eulogy by the leading American historian of mathematics David Eugene Smith in his "The early contributions of Carl Schoy" (1926): 28-31, and the obituary by one of the leading German historians of Islamic science, Julius Ruska, in his "Carl Schoy" (1927).

Amongst the first manuscripts I looked at in the Egyptian National Library was one containing an enormous set of tables with 34,000 entries attributed to Ibn Yūnus. It displayed the lunar equation, that is, the adjustment to the mean position to obtain the true position. The equation is a complicated function of two arguments that can be taken from the mean-motion tables, but Ibn Yūnus decided to construct a highly ingenious double-argument table called by the mysterious name حبطق, *ḥabṭaq*, that would yield the lunar equation from these two arguments without any calculation at all. In another manuscript of Yemeni provenance, I found an auxiliary table whose only purpose could have been to construct Ibn Yūnus' remarkable double-argument table; this provided the explanation of how he did it. The leading astronomer in Cairo in the 15th century, Ibn al-Majdī, stated that he had seen such a *ḥabṭaq* table, but he failed to appreciate its ingenuity.[556]

As an example of material missing from the extant manuscripts of the *Ḥākimī Zīj* we may cite Ibn Yūnus' highly complicated theory of lunar crescent visibility, recovered in later Egyptian and Yemeni manuscripts.[557]

Petra Schmidl, "Astronomy and astrology in Timbuktu: A first preliminary hand-list with a selection of the manuscripts preserved in the Institut des Hautes Études et de Recherches Islamiques – Aḥmad Bābā (IHERI-AB)", to appear.

Amongst the last manuscripts I looked at was number 2163 in the Ahmed Baba Library in Timbuktu.[558] This is an unbound set of 11 loose folios

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556 King, "A double-argument table for the lunar equation attributed to Ibn Yūnus" (1974). On solar, lunar and planetary equations see the article "Taʿdīl (mainly equations and interpolation)" in *Enc. Islam*, 2nd edn. On the term حبطق, *ḥabṭaq*, see n. 570 below.

557 King, "Ibn Yūnus on lunar crescent visibility" (1988).

558 My colleague Benno van Dalen kindly provided me with a set of digital images of each side of each leaf. The astronomical manuscripts were catalogued by my

eaten by weather and worms around the edges containing a disordered, incomplete set of astronomical tables. Several of these are said to be computed by Ibn Yūnus; others may be from the late-13th-century Cairo astronomer al-Marrākushī, but this needs to be investigated. I would date the folios to the 13th century or thereabouts. There are fragments of lists of equations (a:b=c:d, where a,b,c,d, written in words, are trigonometric functions of astronomical quantities) relating to spherical astronomy and astronomical timekeeping; of tables of star positions; of geographical tables, of various trigonometric tables, of tables of the lunar equation and the lunar velocity.

Three other tables are of particular interest to the present study since they are not known to be preserved in any other source. First, a table of the altitude of the sun at the *ʿaṣr* prayer, with values in degrees and minutes for each degree of solar meridian altitude, stated to be universal (*āfāqī*), that is, valid for all latitudes. Second, a fragment lacking title of a table of [the solar altitude at the time of the *ʿaṣr* prayer], with values to degrees and minutes for each degree of latitude from 0° to 66° and each 30° of solar longitude. Third, fragments of a table of time since sunrise (*al-dā'ir*), or time remaining till sunset, given in equatorial degrees and minutes for each degree of meridian altitude and each degree of solar altitude (called *al-buʿd al-shamālī*), calculated for [latitude 30°, Cairo]. (These last tables, originally with over 3,000 entries, are of the same kind as those for Baghdad by one of Ibn Yūnus' sources, namely, the 10th-century Baghdad astronomer, ʿAlī ibn Amājūr.[559]) All three of these tables are not part of the

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colleague Petra Schmidl in "Astronomy and astrology in Timbuktu: A first preliminary hand-list with a selection of the manuscripts", in press.

See the article "Timbuktu manuscripts" on Wikipedia, which shows two pages from this very manuscript.

559 ʿAlī ibn Amājūr compiled two tables with this format, one for the latitude of Baghdad based on an accurate formula, and one for all latitudes based on an approximate formula. On these see King, *Synchrony*, vol. 1 (2004), pp. 235-236.

tables which later constituted the Cairo corpus – see below – but they confirm that Ibn Yūnus was a master of spherical astronomy, something that is already obvious from his astronomical handbook, the *Ḥākimī Zīj*.

(The myths about Ibn Yūnus)

> "(Ibn Yūnus) observed more than 10,000 entries for the Sun's position for many years using a large astrolabe with a diameter of nearly 1.4 meters." Wikipedia article on "Egyptian astronomy." (But the Egyptian astronomer calculated his solar, lunar and planetary tables using single values for each of the mean-motions, as did all medieval astronomers. There is no record that he used an astrolabe of anything like this size, and no large armillary ring was built in Cairo during his life-time, but rather after his death in the ill-fated 'observatory' of al-Afḍal / al-Baṭā'iḥī (1120-1125) – see Sayılı, *The Observatory in Islam* (1960), pp. 167-177.
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> "Ibn Yunus's critical reassessment of the Greco-Roman astronomer Ptolemy, whose Amalgest (*sic*) placed Earth at the center of the universe, helped pave the way for the kind of thinking that led to the theory of heliocentrism (*sic*) posed by 15th century Polish astronomer Nicolaus Copernicus." Tom Verde, "Cairo's House of Knowledge", *Aramco World Magazine* (2019). (If my memory serves me correctly, Ibn Yūnus never mentioned Ptolemy in his known works. It was the 14th-century Damascus astronomer Ibn al-Shāṭir whose geometrical models for the sun, moon and five naked-eye planets were identical to those proposed by Copernicus, but that has nothing to do with heliocentricity, a notion proposed already in Antiquity and also in the medieval Islamic world. But Copernicus won, even though his work was black-listed by the Church for 200 years.)

Various well-established myths about Ibn Yūnus have been demolished[560] by showing how they originated in the early modern literature or through misidentifications in manuscripts:

- "He had a well-equipped observatory." He had no observatory; according to his own testimony, his recorded observations were made on the roof of his house in Fustat or on the roof of a local mosque or, on occasion, on the Muqaṭṭam hills.[561]
- "He was the inventor of the pendulum." There is no evidence to substantiate this myth which started in 17th-century Oxford and has continued in some uninformed circles until the present day.[562]
- "He discovered the prosthaphaeresis formula for the sine of the sum or difference of two angles." Two of his different solutions for problems of plane trigonometry are indeed related by the prosthaphaeresis formula; that does not mean he invented the formula. There are dozens and dozens of formulae in the *Ḥākimī Zīj* that are worth looking at and show how adept Ibn Yūnus was in spherical astronomy.[563]
- "He was the inventor of the candle-clock." This stems from confusion with the 13th-century scholar Kamāl ibn Yūnus, who did write a treatise on the candle-clock.[564]

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560 The myths are dealt with in King, *Astronomical works of Ibn Yūnus* (1972), pp. 6-7.

561 Ibn Yūnus' 'observatory' is demolished already in Sayılı, *The Observatory in Islam* (1960), pp. 131-156.

562 On the pendulum myth see further https://muslimheritage.com/ibn-yunus-and-the-pendulum-a-history-of-errors/.

563 On the prosthaphaeresis formula myth see King, *Astronomical works of Ibn Yūnus* (1972), p. 149.

564 On the candle-clock confusion see www.academia.edu/34695717/, p. 286, n. 2, also Turner, "Yūnus the candle-clock maker and Babylonian functions" (1995).

- "He was the author of an astrological treatise on the heliacal risings of Sirius." This stems from a corruption of *al-Ḥakīm*, "the wise man", into *al-Ḥākimī*, a popular epithet of Ibn Yūnus derived from the name of his patron.[565]

These old myths keep cropping up on the internet even though they were demolished over 50 years ago. The fact that they have no historical foundation cannot diminish the achievements, the reputation and the influence of the leading astronomer of Islamic Egypt. On the internet he is alas lost in a pile of rubbish.[566] The quote from Wikipedia at the beginning of this section shows how these kind of myths get started.

Astronomical handbooks with tables for planetary and spherical astronomy

Over the centuries Egyptian astronomers used the *Zīj* of Ibn Yūnus and imported later works of the same kind from Damascus, Samarqand and then Istanbul, and finally from Paris.[567] Considerable confusion surrounds the main *zīj* that was used in Cairo in the 13th century: it was called *al-Zīj al-Muṣṭalaḥ* and is not extant in its original form; nevertheless, the surviving fragments contain important "lost" chapters from the *Ḥākimī Zīj*.[568]

During the period 1273-1284 a series of observations was made by unidentified astronomers in Alexandria and in Qus in the Nile Valley; we

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565 On the false attribution to Ibn Yūnus of this astrological treatise see King, *Cairo Survey* (1986), n. B59 / 5.1.1. It resurfaces in Rapoport & Savage-Smith, *Lost Maps of the Caliphs* (2018), p. 283, n. 145.

566 As in the Wikipedia article "Egyptian astronomy".

567 For the context of the Egyptian *zīj*es see King & Samsó & Goldstein, "Astronomical handbooks and tables from the Islamic world (750-1900)" (2001), esp. pp. 49-51.

568 See *Cairo Survey*, nos. C12-13.

have their reports in a Yemeni *zīj* preserved in manuscripts in Alexandria and London.[569]

The early-13th-century Coptic scholar al-Asʿad from the family known as Ibn al-ʿAssāl compiled extensive tables for the sun and moon, extant in a manuscript in Cairo that has never been studied.[570] The origin of the mysterious medieval Arabic technical term حبطق, *ḥabṭaq*, becomes clear from this *zīj*.[571] Ibn al-ʿAssāl's work is on a completely different, that is, more sophisticated level than that of the better known contemporaneous Coptic scholar Abū Shākir, whose work on history, astronomy and calendrics is lost in the original Coptic but been published by Otto Neugebauer from the Ethiopic version.[572]

In the 14th century Aḥmad al-Kawm al-Rīshī prepared a recension for Cairo of *al-Zīj al-Jadīd* of Ibn al-Shāṭir of Damascus, and at the end of the 15th century Ibn Abi ʻl-Fatḥ al-Ṣūfī prepared a recension for Cairo of the *Sulṭānī Zīj* of Ulugh Beg of Samarqand. Both were used in Cairo until the 19th century.

The later materials for mathematical astronomy in Cairo have never been studied: for example, by Riḍwān Efendī al-Razzāz *ca*. 1700, a *zīj* of some 200 pages based on Ulugh Beg, auxiliary tables in 800 pages for calculating ephemerides, prayer-tables for Mecca, and tables of coordinates for marking vertical sundials.[573] If the scholars of Napoleon, or, for that matter, Edward Lane, had seen any of these, they might have shown a little more respect for astronomy in Islamic Egypt. Meanwhile,

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569 King & Gingerich, "Some astronomical observations from 13th-century Egypt" (1982).

570 *Cairo Survey*, no. C10. On the family see the article "Ibn al-ʿAssāl" in *Enc. Islam*, 2nd edn. by A. S. Atiya. On the term حبطق, *ḥabṭaq*, see n. 556 above.

571 Compare *Cairo Survey*, no. B59/2.1.6 and C10/2.5.3.

572 Otto Neugebauer, *Abu Shaker's 'Chronography' (1988)*.

573 *Cairo Survey*, no. D58.

back in Paris, French orientalists were studying the far more impressive *Ḥākimī Zīj* of Ibn Yūnus. A recent study by the Egyptian scholar Sabri al-ʿAdl of astronomy in Egypt according to the *Chronicle* of al-Jabartī barely ventures beyond what limited information is in the *Chronicle*, and the author approaches this or that manuscript in the Egyptian National Library gingerly, apparently unaware that the Cairo astronomical manuscripts have been catalogued.[574] He shows the interest of al Jabartī himself in these sciences, as witnessed by the fact that he himself copied many books in astronomy and other applied sciences and owned an enormous library inherited from his father and possessed numerous scientific instruments. Nevertheless, the author is able to confirm that the exciting days of Mamluk astronomy were long gone.

Annual ephemerides

Annual ephemerides, that is, tables giving the positions of the sun, moon and five naked-eye planets for each day of a given year, were prepared in Baghdad in the 9th century and in Cairo not long after. They include horoscopes of significant times during the years. Ibn Yūnus noted discrepancies in the ephemerides prepared with the *Mumtaḥan Zīj*, the principal production of the astronomers of early-9th-century Baghdad. Fragments of such ephemerides and astronomical/astrological calculations for horoscopes, based on the parameters of Ibn Yūnus, have been recovered from amongst the treasures of the Cairo Geniza and analyzed by Bernard Goldstein and David Pingree.[575] A series of other important fragments have been analyzed by Johannes Thomann.[576]

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574 Sabri al-ʿAdl, "The study of astronomy according to the *Chronicle* of al-Jabarti" (2005).

575 Goldstein & Pingree, "Astronomical computations for 1299 from the Cairo Geniza" (1985), and other articles by the two authors.

576 See Thomann, "An Arabic ephemeris for the year 954/955 and the geographical latitude of al-Bahnasā" (2013); "An Arabic ephemeris for the year

Otherwise not a single complete medieval Egyptian ephemeris is known to survive, although we can assume that they resembled those that have survived from Rasulid Yemen.[577]

The main purposes of these ephemerides – see **Pl. S2a** –beyond the tabulation, for each day of a specific year, of the positions of the sun, moon and naked-eye planets, and the presentation of general astrological predictions based mainly on their positions relative to one another, was the determination of the possibility of the visibility of the lunar crescent on the first day of each civil month and the calculation of horoscopes for various special occasions.

A unique kind of ephemeris for Cairo has been preserved in which only calculations for the new moons are presented for each month over a six-year period, namely, 1125-1130 Hijra (= 1713-18).[578] For the first evening of each month in the civil calendar, three quantities are calculated – the apparent angular distance between the sun and moon, the altitude of the moon at first visibility, and the difference in setting time of the sun and moon over the local horizon – and a set of conditions is applied to investigate whether the crescent will be seen clearly or dimly or with difficulty, or will not be seen at all, in which case the new lunar month will begin the next evening.

The ultimate purpose of the standard ephemerides was largely astrological, but their preparation must have kept many an astronomer

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1026/1027 in the Vienna Papyrus Collection" (2014); and "The Arabic ephemeris for the year 1149/1150 and the Arabic 'Baḫnīṭas'" (2015), and several other studies by the same author.

577 King, *Mathematical astronomy in medieval Yemen* (1983), pp. 33 & 39, and pls. 2-3. See also the the article "Taḳwīm (ephemeris)" by Michael Hofelich in *Enc. Islam*, 2nd edn., my article "Ru'yat al-hilāl (lunar crescent visibility)", and the next note.

578 King, "Lunar crescent visibility predictions in medieval Islamic ephemerides" (1991).

employed. The leading astronomer in Cairo at the end of the 15th century, Ibn al-Majdī, himself a *muwaqqit*, compiled a cunning set of tables facilitating the preparation of a series of annual ephemerides.[579] His contemporary the *muwaqqit* Shihāb al-Dīn al-Kawm al-Rīshī, is said by the historian al-Maqrīzī, to have been an expert in compiling ephemerides using the planetary tables in a *zīj*, and it was he who adapted the Damascus *zīj* of Ibn al-Shāṭir to the longitude and latitude of Cairo.[580]

Astronomical timekeeping

Ibn Yūnus was the first Muslim astronomer to prepare a set of substantial tables for timekeeping by the sun and regulating the astronomically-defined times of Muslim prayer. A limited number of these tables occur in his *Zīj*. The tables for timekeeping, totalling some 80 folios or 160 pages, were copied separately from the *Zīj*. These voluminous tables, containing some 30,000 entries, and numerous auxiliary sets of tables for timekeeping, were to make Cairo the world-centre for astronomical timekeeping for several centuries, a fact barely known nowadays, not least because, apart from the tables themselves, we have not a single textual reference to anybody actually using them.[581]

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579 Kennedy & King, "Ibn al-Majdī's tables for calculating ephemerides" (1980).

580 Brentjes, "On four sciences and their audiences in Ayyubid and Mamluk societies" (2017), pp. 146-147, citing al-Maqrīzī, *al-Sulūk*, III, p. 360.

581 The first account of the Cairo corpus was in "Ibn Yūnus' *Very Useful Tables* for reckoning time by the sun" (1973). A more detailed account, with a critical investigation of the authorship, is in King, *In Synchrony with the Heavens*, vol. 1 (2004), II, Ch. 4: "The main Cairo corpus of tables for timekeeping", on pp. 247-282, also Ch. 5: "The development of the main Cairo corpus", on pp. 283-298, Ch. 6: "Other early Egyptian tables for timekeeping", on pp. 299-317, Ch. 7: "Late modifications to the main Cairo corpus", on pp. 318-333, and Ch. 8: "Other late Egyptian tables for timekeeping", on pp. 334-347. See also the text to n. 820 below.

In the first copy to come to our attention, MS Cairo ENL Dār al-Kutub *mīqāt* 108, copied as late as 1803, the corpus was entitled كتاب غاية الانتفاع, (*Kitāb*) *Ghāyat al-intifāʿ*, "*Very Useful Tables*", the expression *ghāyat al-intifāʿ*, "the limit of usefulness", being used in the instructions, and was attributed to the great astronomer Ibn Yūnus. It is this title which has been adopted in the literature.

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Here is a poem attributed to Ibn Yūnus regarding the times of Muslim prayer, with a free prose translation:[582]

ومعرفة الاوقات فرض معين \ على عقلاء المسلمين مؤكد
اتى ذاك في القرآن يا ضاح مجملا \ وفسره خير البرية احمد
فمهما رأيت الظل قد زاد فيئه \ فصل صلاة الظهر اذ ذاك يرصد
وزد قامة ظل الزوال فانه \ اوان لوقت العصر وقت محدد
وعند غروب الشمس قم صل مغربا \ فليس لها وقت سوى ذاك مفرد
وصل العشاء وانت للجو ناظر \ اذ الشفق الاعلى يغيب ويفقد
وآخر هذا الوقت ان شئت فانتظر \ الى ثلث الليل انتظارك اجود
ولا تنتظر حتى البياض فانه \ يدوم زمانا في السماء ويوجد
وايقن بان الفجر فجران عندنا \ وميزهما حقا وانت المقيد
فاول فجر منهما طالع كما \ ترى ذنب السرحان في الجو يصعد
وهذا كذوب ثم آخر صادق \ تراه منيرا ضوؤه يتوقد
وآخر هذا الوقت مطلع شمسنا \ اذا فاتك الوقت الذي هو اجود
ولا خير فيمن كان بالوقت جاهلا \ ولم يك ذا علم بما يتعبد

[582] See King, *In Synchrony with the Heavens*, vol. 1 (2004), p. 215, for information on the available manuscripts. The edited text is in "Astronomical timekeeping in 14th-century Syria" (Arabic version) (1978), pp. 393-394. In some sources the poem is attributed to Ibn Yūnus' famous ancestor, the legal scholar al-Shāfiʿī (d. 819/20), but the definitions of the time of the *ʿaṣr* prayer had not been formulated in his time. On Ibn Yūnus' poetry see also n. 201 above.

> "Knowing the prayer-times is a prescribed duty for discerning Muslims. This is summarized in the *Qur'ān*, my friend, and was explained by Aḥmad [*i.e.*, the Prophet Muḥammad, referred to as Aḥmad in the *Qur'ān*], the most outstanding of men. Perform the midday prayer whenever you observe the shadow starting to increase. Add a length (of the gnomon) to the shadow: this gives you (the shadow) at the time of the afternoon prayer. At sunset get up and perform the evening prayer: this is the only permissible time. Perform the night prayer when, looking at the sky, you see the upper part of the evening twilight fade away and disappear. As for the end of this prayer time, if you wish you can wait until one-third of the night; indeed, it is better that you wait. But do not wait until whiteness appears (on the eastern horizon): it will last for a time in the sky. Bear in mind that there are two stages of daybreak according to our doctrine: distinguish between them carefully – you are the one who decides this. The first daybreak looks like a wolf's tail rising in the sky: this is the false dawn. The later one is the true dawn: you see it illuminate the sky like a fire. The end of this prayer-time is sunrise: at that moment the best time for prayer is over. There is no virtue in a person who is neglectful of the prayer-times, and he has no knowledge of Him who is to be worshipped."

The tables for the prayer-times in the Cairo corpus are based on such prescripts.

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In addition to using the main corpus, Egyptian astronomers prepared additional tables of numerous functions relating to astronomical timekeeping that had not been tabulated previously and were never tabulated again. Particularly impressive are the tables and also instruments intended for the solution of astronomical problems for all latitudes.[583]

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[583] King, "Universal solutions in Islamic astronomy" (1987), and "Universal solutions to problems of spherical astronomy from Mamluk Syria and Egypt" (1988), repr. in *Synchrony*, vol. 1 (2004), VIa: 679-710, and VIb: 711-740.

Worthy of special mention is the universal auxiliary table by Najm al-Dīn al-Miṣrī *ca*. 1325 for solving all of the standard problems of spherical astronomy by day and by night for all latitudes. This contains a monumental total of some 440,000 entries, and is preserved in a single manuscript surviving in two enormous halves in Cairo and Oxford. A detailed analysis has been published by François Charette.[584] We suspect that this unique manuscript is in the hand of the author, and we doubt that the work would have attracted any copyists.[585]

The *muwaqqit*s

It was in Cairo, probably in the 13th century, that we find the first evidence the institution of the *muwaqqit* or astronomer associated with a religious institution and concerned mainly with such problems as the regulation of the lunar calendar, the organization of the five prayers, and the determination of the *qibla*. It has always been assumed that the activities of the *muwaqqit*s were of limited scientific potential as well as of little historical interest. My own research, dedicated to my distinguished colleague, the late Abdelhamid I. Sabra (1924-2013), has shown that the achievements of the *muwaqqit*s, as we can best judge from the treatises and tables they left behind, were not at all without significance, either from

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[584] On Najm al-Dīn and his rediscovery see n. 861 below. On this tables see Charette, “A monumental medieval table for solving all the problems of spherical astronomy for all latitudes” (1998), also *Synchrony*, vol. 1 (2004), I: 69-71 & 167-169.

[585] In like fashion, the German astronomer Friedrich Christoph Müller in Leipzig *ca*. 1790 wrote in the introduction to his enormous tables of time as a function of solar altitude and day of the year for each degree of latitude from 47° to 54°, complained that he had difficulty in finding a publisher for these tables. See further King, *In Synchrony with the Heavens*, vol. 1 (2004), II:10 “European tables for timekeeping”, pp. 184-190, esp. 186-188.

a religio-cultural or a scientific point of view.[586] Not only did the *muwaqqit*s in Cairo in the 13th to 15th centuries make contributions to universal solutions in spherical astronomy, in astronomical instrumentation, and in facilitating the preparation of annual ephemerides, but in the 14th-century their colleagues Ibn al-Shāṭir and al-Khalīlī in Damascus and Ibn al-Sarrāj (who was not a *muwaqqit*) in Aleppo between them produced new planetary models, tables for the universal solutions of all problems in spherical astronomy, the most spectacular sundial from between Antiquity and the Renaissance, and the most sophisticated astrolabe ever made.[587]

Astronomical instruments

Our understanding of the development of instrumentation in medieval Egypt is hampered by the fact that although we have major treatises that are preserved, most of the instruments themselves have not survived the vicissitudes of Mamluk and Ottoman history.

Considerable mystery surrounds the achievements of ʿAlam al-Dīn Qayṣar known as Taʿāsīf, who was born in Asfūn above Luxor in Upper Egypt in 1178 and died in Damascus in 1252. [588] He was a scholar of Islamic law,

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586 King, "On the role of the muezzin and *muwaqqit* in medieval Islamic society", (1996), with a new version in *Synchrony*, vol. 1 (2004), V: 623-677.

The Wikipedia article on muwaqqits is better than most Wikipedia articles on aspects of Islamic astronomy, but curiously omits any reference to their major productions, that is, tables, tables, tables ... ; see https://en.wikipedia.org/wiki/Mu—*—waqqit. Modern rables for prayer-times are mentioned, but not that they have a history of a thousand years.

587 "L'astronomie en Syrie" (1994), with part of the original English version in *Synchrony*, vol. 2 (2005), XIVb-c: 659-744.

588 ʿAlam al-Dīn Qayṣar has not fared well in the modern literature. Suter's 1900 survey of Muslim scientists gives references to medieval biographical sources (no. 358). Savage-Smith's repertory of Islamic globes includes his globe (no. 3), published in 1790 by Simone Assemani (السمعاني). The Rosenfeld-İhsanoğlu survey

an engineer of international renown, and a mathematician of distinction. He worked in Mosul, Ramla, Hama, and Cairo, and his engineering accomplishments are better known than his scientific ones. In 1225/26 he made a spectacular celestial globe showing Ptolemy's 1025 stars for al-Malik al-Kāmil (either in Egypt or Syria), which is preserved in the Museo Nazionale di Capodimonte in Naples. One does not just sit down and make a masterpiece like this; he surely made other instruments that have not survived.[589] ʿAlam al-Dīn Qayṣar also constructed the famous water-wheels on the Orontes River at Hama.

Around 1280 the Moroccan astronomer Abū ʿAlī al-Marrākushī compiled in Cairo a monumental work on astronomical instruments and spherical

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of Muslim mathematicians and astronomers documents his surviving mathematical writings (no. 583). As is often the case, one of the best sources on him is Sarton's *Introduction to the History of Science* (vol. II:2, pp. 623-624). However, there is no entry for him in the *Encyclopaedia of Islam*, no entry in the *Dictionary of Scientific Biography*, and no entry in the *Biographical Encyclopedia of Astronomers* (in which the most important instrument-makers should have been included but were not). My survey of the Cairo scientific manuscripts uncovered nothing related to him. A useful summary of his achievements by Terry Allen in the context of his investigations into Ayyubid Architecture is available at www.sonic.net/~tallen/palmtree/ayy—*—arch/qaysarx.htm.

589 The unique complete spherical astrolabe signed by "Mūsà" "dated 1480" "origin Egypt? Syria?" is preserved in the History of Science Museum in Oxford. In 2018, what was first thought to be an early work by the mysterious maker of the Oxford piece turned out to be a modern fake, but at least its appearance prompted detailed study of both pieces. This led both to the realization that the Oxford piece served the latitude of Istanbul and to the identification of "Mūsà", namely, as the Jewish medic and astronomer and engineer Mūsà Jālīnūs, *fl*. Istanbul, *ca*. 1480. Thus a mystery that had lasted some 60 years since the real piece was acquired by the Museum was solved. See King, "Spherical astrolabes in circulation" (2018), and related illustrations.

astronomy.[590] This was highly influential in later Islamic astronomy, if only in Egypt, Syria and Turkey. The first half on spherical astronomy and sundials was translated by Sédillot-*père* in 1834, and the second half on other instruments was summarized by Sédillot-*fils* in 1844.[591] We shall mention below the Cairo astronomer Najm al-Dīn al-Miṣrī who compiled around 1325 a treatise describing and illustrating some 100 different instrument-types invented by himself or known to him.[592] This, unlike the treatise of al-Marrākushī, had very little influence, even in Cairo.

Astrolabes and sundials existed in profusion in medieval Cairo from the 10th century onward. The sundials were mainly fixed in all of the major mosques.[593] To take just one example: the scholars of Napoleon discovered inside (!) a column in the Mosque of Ibn Ṭūlūn the fragments of a marble sundial. They dutifully laid the fragments out on a horizontal surface as best they could and made an engraving of them, which was appropriately included in the *Description de l'Égypte* – **Pl. S10**. The fragments disappeared overnight and were never recovered. The sundial was made for the mosque in 696 Hijra (1296/97) and has been studied in detail within the rich context of gnomonics (sundial theory and construction) in medieval Egypt.[594] A vertical sundial in the *Madrasa* of al-Ashraf Īnāl in the Northern Necropolis, constructed by a leading astronomer and gnomonics expert Ḥasan al-Ṭubnī (al-Karādīsī) in 871 H (1466), has been

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590 See François Charette's article "al-Marrākushī" in *BEA*, which is superior to mine in *Enc. Islam*, 2nd edn.

591 See the works listed under Sédillot-*père* and Sédillot-*fils*.

592 Arabic edition, English translation and detailed commentary in Charette, *Mathematical instrumentation in 14th-century Egypt & Syria* (2003).

593 On Mamluk sundials see the article "Mizwala (sundials)" in *Enc. Islam*, 2nd edn.; King, *In Synchrony with the Heavens*, vol. 2 (2005), X: 81-98; Charette, *Mathematical instrumentation in 14th-century Egypt & Syria* (2003), pp. 181-208.

594 *Description de l'Égypte*, II, pl. c / p. 746. For an analysis see Janin & King, "Le cadran solaire de la mosquée d'Ibn Ṭūlūn au Caire" (1978).

investigated by the Polish historian of Islamic architecture Maciej Witkowski.[595] (Yes, sundials belong to the study of medieval Islamic architecture, not least because a sundial was a standard feature of medieval mosques and *madrasa*s.) The surviving Cairene sundials from before 1500 can be counted on the fingers of one hand. Numerous surviving Ottoman examples are frankly less inspired, and most are non functional anyway, having long been relieved of their gnomons.

Of astrolabes made or used in medieval Egypt there are but few that have survived. Two fragmentary astrolabes made in Baghdad *ca*. 950 by Ḥāmid ibn ʿAlī al-Wāsiṭī, one of two leading astrolabists there, bear markings showing that they were used in Egypt. Indeed, it is possible that at least one of these very astrolabes was known to Ibn Yūnus, for the latter states that he made observations with an astrolabe made by Ḥāmid, and elsewhere praised the prowess of its maker.[596] The piece is preserved in the Museum of Islamic Art in Cairo and some joker has riveted a spurious rete (star-map) to the mater (main-frame) so that there is no access to the geographical plates; this is reprehensible but I could not persuade the museum authorities to remove the rivet. Monumental astrolabes are not known to have been made in Cairo, as they were made in Damascus; two such splendid instruments signed by one ʿAbd al-Karīm al-Miṣrī were made in Damascus, not in Cairo. An astrolabe by Ḥasan ibn ʿUmar al-Naqqāsh dated 681 Hijra (1282/83), made in Cairo and now preserved in Istanbul, has inscriptions in Arabic but uses Coptic numerals – **Pl. S14**.[597]

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595 Witkowski, "Vertical sundial from the Madrasa of Al-Ashraf Inal" (2014). On the maker see Mayer, *Islamic astrolabists and their works* (1956), p. 47, and *Cairo Survey*, no. C90.

596 King, *In Synchrony with the Heavens*, XIIIc: 439-544 "The earliest astrolabes from Iraq and Iran (*ca*. 850 - *ca*. 1100)", esp. 8.2: 496-503.

597 A list of Islamic instruments up to 1500 is in King, *In Synchrony with the Heavens*, XVIII: 993-1020. This is the table of contents of a catalogue of the corpus available at www.academia.edu/35737806/.

The Aleppo astronomer Ibn al-Sarrāj constructed in 1328/29 an astrolabe that was universal – that is, usable for all terrestrial latitudes – in five different ways. This is without doubt the most sophisticated astrolabe ever made and very few astronomers, medieval or modern, could fathom how it was intended to be used. Ibn al-Sarrāj apparently did not compile a treatise on the use of this remarkable instrument, but it was acquired in 1475 by one of the leading Egyptian astronomers, ʿIzz al-Dīn al-Wafā'ī, who worked as a *muwaqqit* in the al-Mu'ayyad Mosque in Cairo. al-Wafā'ī announced that since Ibn al-Sarrāj had produced the device without instructions, he himself would remedy the situation. al-Wafā'ī's treatise on the use of this complicated mechanism is happily preserved for us in a manuscript in Princeton University Library. The astrolabe passed through the hands of altogether four Cairo astronomers, whose names are engraved on it after the name of al-Wafā'ī, the last of whom acquired it in 1856, before it was sold to the dealer Ali Beg in Baghdad. In 1921 it was purchased by the Greek collector of Islamic artefacts, Antonis Benakis (1873-1954), and it is now in the Benaki Museum in Athens.[598]

The astrolabe featured in the *Description de l'Égypte* is of 13th- or 14th-century Maghribī provenance – **Pl. S13** – and what happened to it after *ca.*

On this particular astrolabe see also *World-Maps for finding the direction of Mecca* (1999), pp. 76-78 & 600-602. It would provide a sixth object for Tamer el-Leithy, who gave a lecture in Kuwait at the Dar al-Athar al-Islamiyya in January, 2020, entitled "Converting objects and words: Egypt's Arabization in five objects (11th-14th c.)" and presenting private family letters, a magical talisman, an exquisite Coptic-Arabic Bible, a humble petition, and a Christian *fatwa* (legal responsum).

[598] The astrolabe is described in King, "L'astronomie en Syrie" (1993), pp. 434-435 (no. 330); *idem*, *In Synchrony with the Heavens*, II (2005), pp. 694-700. A detailed description of the piece in the light of various relevant texts is in Charette & King, *The Mathematical Jewel of Ibn al-Sarrāj* (to appear). A video of Martin Brunold, the Swiss technician who had the unique combination of talents, including *amore*, to make copies of this piece, is at www.shadowspro.com/en/links-on-astrolabes.html (with a false title "Astrolabe Tourbillon by Louis Moinet").

1800 is unknown.[599] Astrolabes are not known to have been made in Egypt after about 1500, whereas in India, Iran, Turkey and Morocco they were made until the 19th century. Whether they were used there for serious purposes is debatable.

Also very few astrolabic quadrants are known from Egypt, even though the instrument was invented in Cairo in the 12th century and dozens of treatises on its use were compiled during the Mamluk and Ottoman periods.[600] Hundreds survive from Ottoman Turkey.

Mathematical geography

Already Ibn Yūnus included in his *Zīj* an enormous geographical table with longitudes and latitudes for some 290 localities from al-Andalus to China. His values relied heavily on those in the *Geography* of al-Khwārizmī (Baghdad, *ca*. 825).[601] Various lesser Egyptian astronomers produced similar tables, invariably with Maghribī influence, and tabulated the *qibla* for each locality.[602] The only known serious world-map from an

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599 *Description de l'Égypte*, É.M., II, pl. HH / p. 737. See Sédillot-*fils*, "Mémoire sur les instruments astronomiques des Arabes" (1844), 166-172, with hand-drawings; also Gunther, *Astrolabes of the world* (1932), I, pp. 282-283, and a brief description by the late Francis Maddison in Anderson & Fawzy, eds., *Egypt Revealed: Scenes from Napoleon's "Description de l'Egypte"* (1987), pl. 174 on p. 194.

600 On the quadrant see the article "Rubʿ (quadrant)" in *Enc. Islam*, 2nd edn.; King, *In Synchrony with the Heavens*, vol. 2 (2005), X: 71-80 (general), and XI: 111-197 & XIIa: 199-258 (universal horary quadrant); also Charette, *Mathematical instrumentation in 14th-century Egypt* (2003), pp. 113-138 & 209-220. For the most remarkable Ottoman example see King, *Synchrony*, vol. 2, pp. 721-724.

601 Kennedy & Kennedy, *Islamic geographical coordinates*, pp. xxxvi & 437-441.

602 These are published in King, *World-Maps for finding the direction and distance to Mecca* (1999), pp. 76-84 & 600-622, and "Mathematical geography from 15th-century Egypt", pp. 13-19 (partial edition of table by Ibn al-ʿAṭṭār).

Egyptian source based on such coordinates is found in a treatise on folk astronomy from *ca.* 1300 and the world-map itself is in the tradition of the great Central Asian scholar al-Bīrūnī, but the only surviving copy is not without its problems.[603]

A world-map on silk was prepared in 964 by order of the Caliph al-Muʿizz (*reg*. 953-975). On it were marked the climates, mountains. rivers, seas, and different routes, as well as cities, with Mecca and Medina prominently marked. No grid is mentioned in our source, inevitably al-Maqrīzī, but he tells us that it cost 22,000 dinars. It apparently bore strong resemblance to the world-map of al-Khwārizmī, prepared in Baghdad some 125 years previously.[604]

We have already mentioned the world-map of Ibn Faḍlallāh al-ʿUmarī, which has been incorrectly claimed to be the world-map of the Abbasid Caliph al-Ma'mūn. See the next section on folk astronomy for an Egyptian rendition of a world-map in the tradition of al-Bīrūnī.

The spectacular series of world-maps and provincial maps featured in the unique 13th-century copy of the late-11th(?)-century Egyptian treatise كتاب غرائب الفنون وملح العيون, *Kitāb Gharā'ib al-funūn wa-mulaḥ al-ʿuyūn*, now known as the *Book of Curiosities*, is not in this Egyptian tradition of mathematical geography and its context remains obscure; from Egypt we

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603 King, "A world-map in the tradition of al-Bīrūnī and al-Khāzinī presented by al-Sajāwandī" (2007).

Much silliness in the modern literature results from the fact that al-Bīrūnī included in his introduction to astronomy and astronomy a simplistic map of the world, and the modern literature, which calls this "The al-Bīrūnī world- map", knows nothing of his other, more serious contributions to cartography and mathematical cartography. These are summarized in King, *World-Maps for finding the direction to Mecca* (1999), pp. 339-344, esp. n. 63 on p. 344.

604 King, *World-Maps*, p. 35, quoting al-Maqrīzī, *Khiṭaṭ*, II, 267.

know of nothing vaguely related before it and nothing after it.[605] A single floating scale on a world-map is the sole indication that at least this particular map might come originally from a serious tradition of mathematical geography. The work is a mine of information on a multitude of subjects. Eight other copies, mainly lacking the illustrations, have been identified by the diligent editors of this remarkable work, Emilie Savage-Smith and Yusuf Rapoport.

Various geographical tables were compiled in Cairo after the 13th century showing the *qibla* as well as longitudes and latitudes, but these were not of the same quality or accuracy as the ones from Central Asia or Syria mentioned above.

Folk astronomy

> "Modern accounts of Islamic astronomy, with their emphasis upon technical achievements, tend to ignore the scientific folklore that flourished alongside mathematical astronomy in the Islamic world throughout the medieval period. This folk tradition was far more widely practiced than the mathematical tradition, yet the sources available for studying it have received far less attention in modern times. These sources are mainly written ones, but the application of folk astronomy in the Islamic world sometimes led also to the use of astronomical alignments in Islamic religious architecture. Furthermore, such alignments are actually advocated in texts that are still extant. Thus the study of Islamic folk astronomy provides an important case study in which ethnohistorical and archaeo-astronomical evidence are intricately combined." D. A. King, "Folk astronomy in the service of religion: The case of Islam" (1993), p. 124.

> "Evidence provided in the *Book of Curiosities* suggests that in

[605] Savage-Smith & Rapoport, *An Eleventh-Century Egyptian Guide to the Universe* (2014).

> Egypt during the early 11th century a simplified form of reading the stars and skies existed alongside the more technical and mathematically demanding forms of the art employing horoscopes and astronomical calculations. Here we have seen prognostication based on the visibility of important stars, the occurrence of a planet on the eastern horizon, the rising of one of the lunar mansions, the appearance of comets, and the occurrence of earthquakes and winds. This nontechnical form of astronomy is sometimes termed "folk astronomy". This may have been the level of astronomical and astrological lore that circulated among the generally educated and ambitious classes of Egyptian society. The *Book of Curiosities* was certainly not aimed at a readership comprised either of professional astronomers or astrologers." Youssof Rapaport & Emilie Savage-Smith, *The Lost Maps of the Caliphs* (2018), pp. 69-70.

It was in the 1980s that the expression "folk astronomy" was introduced into the English-language literature on the history of Islamic astronomy. More recently the term "ethnoastronomy" has been used in the literature on archaeoastronomy for what was practiced in all cultures of the world in the way of non-mathematical astronomy. Before then, in the Muslim world we had various non-technical almanacs (Dozy, Pellat) and religious cosmology (Heinen). It was the discovery of the ways that "folk astronomy" was used in the service of Islamic ritual that necessitated a new expression to counter the mathematical (*zīj*es) and theoretical (*hay'a*) astronomy which were reasonably well documented. This "folk astronomy" involved timekeeping using arithmetical shadow-schemes by day and lunar mansions at night. It also involved finding the *qibla* using astronomical horizon phenomena as part of an extensive tradition of sacred geography.

(None of this features in the *Book of Curiosities*, so I cannot be as certain as Rapaport and Savage-Smith that the readers of the *Book of Curiosities* would find there the folk astronomy they needed. I am more tempted to enquire how many manuscript copies were ever made of the *Ḥākimī Zīj*, as a monument to mathematical astronomy, and of the *Book of Curiosities*, as a monument to cosmography and cartography. In the case of the former,

we have only three surviving fragments representing about three-quarters of the whole, and in the case of the latter, one fine copy and eight non-representative fragments. In comparison, the major scientific productions of the great al-Bīrūnī (Ghazna *ca*. 1025), apart from his *Zīj* entitled *al-Qānūn al-Masʿūdī* (15 copies), survive mainly in unique manuscripts or are lost but for their titles.)

The tradition of folk astronomy that flourished alongside mathematical astronomy in Islamic civilization also had various interesting manifestations in Egypt. A very important Egyptian treatise on folk astronomy preserved in a unique 13th-century manuscript in Princeton remains to be studied properly, but it has already provided us with a corrupt world-map in the tradition of al-Bīrūnī[606] and a new account of the geodetic observations of the astronomers of the Abbasid Caliph al-Ma'mūn (*reg*. 813-833).[607]

Alongside the complex tables of the Cairo corpus, simple arithmetical schemes for reckoning time of day in seasonal hours from shadow lengths are found in numerous Egyptian folk astronomical and legal sources.[608] A unique manuscript in the Chester Beatty Library in Dublin preserves for us a set of illustrated tables from *ca*. 1300 for time-keeping by night using the lunar mansions. The table, by a previously unknown astronomer whose name can be read on the damaged title-page as ... (?) ibn Hārūn al-Ṣiqillī (from Sicily), is the only one of its kind.[609]

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606 See n. 603 above.

607 King, "Too many cooks ... the first Islamic geodetic measurements" (2000) (also n. 508 above).

608 King, *Synchrony*, vol. 1 (2004), III: 510-518.

609 *Ibid*., III: 512-513, and, for a more detailed discussion, Schmidl, "Time-keeping by the lunar mansions in medieval Egypt" (2006).

Agricultural almanacs such as are known from al-Andalus to Central Asia to the Yemen are also known from medieval Cairo.[610] We now jump to a very different subject.

The instruments of the French admired by al-Jabartī

> "(The French) possess extraordinary astronomical instruments of perfect construction and instruments for measuring altitude of wondrous, amazing, and precious construction. And they have telescopes for looking at the stars, and measuring their scopes, sizes, heights, conjunctions, and oppositions, and the clepsydras and clocks with gradings and minutes and seconds, all of wondrous form and very precious, and the like." al-Jabartī in his *History of Egypt*, cited by Patrice Bret, "Instruments of knowledge and power in a colonial context: Scientific instruments during the French Occupation of Egypt, 1798-1801" (2019), p. 127.

In the first version of the chronicle of the historian ʿAbd al-Raḥmān al-Jabartī (1753-1825),[611] probably written after a visit to the new but short-lived French observatory in Cairo, we find the above laudatory introduction to the astronomical instruments brought to Cairo by the French, and others made by them as soon as they arrived. The "observatory" was as short-lived as several others in Muslim lands had been, and some of the instruments did not withstand riots.

al-Jabartī's account of the French instruments has recently been thoroughly studied by Patrice Bret, a French historian of science and technology and a former senior, now honorary researcher at the Centre Alexandre-Koyré in Paris, whose wide areas of expertise extend to science and technology under colonisation, particularly, Napoleon's Egypt Expedition. His 2019 paper "Instruments of knowledge and power in a

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610 Pellat, *Cinq calendriers égyptiens* (1986).

611 Article "al-D̲jabartī" in *Enc. Islam*, 2nd edn., by David Ayalon. His history has been made accessible by Thomas Philipp and colleagues in a splendid four-volume translation which I have not used here.

colonial context: Scientific instruments during the French Occupation of Egypt, 1798-1801", as one might expect, focusses primarily on French instruments.[612]

It is clear that the rich tradition of medieval Egyptian astronomical instrumentation that had been more or less forgotten by the Egyptians themselves was overlooked by the French. Riḍwān Efendī al-Razzāz was one of the last Egyptian astronomers in the medieval tradition. He flourished *ca*. 1700, a century before the arrival of the French, and he is known to have compiled or copied in his own hand over **two thousand pages of astronomical tables** of one sort or another, including solar, lunar and planetary tables; tables for astronomical timekeeping and regulating the times of prayer; and tables for the construction of sundials.[613] In 1701 he put his name on a fine celestial globe of diameter 18.3 cm with the standard Ptolemaic contingent of 1,018 stars. Somehow Riḍwān's globe ended up in French hands, though not directly and somewhat mysteriously; the accessible historical sources do not tell us when.[614] al-Jabartī mentions this globe and implies that it had earlier belonged to his father, Ḥasan al-Jabartī (d. 1774), who was an astronomer.[615]

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612 Patrice Bret, ed., *L'Expédition d'Égypte, une entreprise des Lumières, 1798-1801* (colloquium proceedings, 1998) (not seen), and *idem*, "Instruments of knowledge and power in a colonial context: Scientific instruments during the French Occupation of Egypt, 1798-1801" (2019).

613 For a list of these tables preserved in manuscripts in the Egyptian National Library see *Cairo Survey*, no. D58. That volume of tables can hardly be original, and indeed they are not: see King, *Synchrony*, vol. 1 (2005), p. 331.

614 Bret, "Scientific instruments during the French Occupation of Egypt" (2019), pp. 207. It seems this globe is what is meant, and that "armillary spheres" are a modern confusion.

615 On the astronomical productions of the father preserved in the Egyptian National Library see *Cairo Survey*, no. D91, where a dozen works are listed,

Involved in the story of the globe was the French medic Antoine-Barthélemy Clot (1793-1868), who, after practicing for a time at Marseilles, was invited by Muhammad Ali, Viceroy of Egypt, to direct the School of Medicine at the Army hospital of Abou Zabel which later transferred to Qasr al-Aini, Cairo. In 1849 Clot returned to Marseilles, though he revisited Egypt in 1856. It was in 1859 that Clot Bey, who was a donor of Egyptian relics to several museums in Russia, presented Riḍwān's globe to the Imperial Public Library in St Petersburg, after 1947 the M. V. Lomonosov Museum, where it is today. I was unable to locate a decent image of this globe; fortunately, its every detail was mentioned by the German orientalist Bernhard Dorn in his description published in St Petersburg in 1865.[616]

In the third and last version of his chronicle al-Jabartī-*fils* also described the sundials of various kinds built by the French astronomer Nicolas-Antoine Nouet (1740-1811) in the Institut d'Égypte complex, the scholar who wrote the astronomical sections in the *Description de l'Égypte*.[617] His descriptions are recorded by Patrice Bret,[618] and I take over the English

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including some solar longitude tables, an almanac and prayer-tables, and treatises on quadrants and sundial construction.

For the son, the same library *Cairo Survey*, no. D92, has solar longitude tables, and an ephemeris for 1209 H (1794/95).

616 On this globe see Dorn, "Drei astronomische Instrumente" (1865), pp. 31-44, with a detailed account of the inscriptions, the star-names and the geographical data; Mayer, *Islamic astrolabists and their works* (1956), pp. 81-82; also Savage-Smith, *Islamicate Celestial Globes* (1985), pp. 233-234 (no. 31). On the significance and context of the geographical data see King, "Ottoman schemes of sacred geography" (1986), and "Finding the *qibla* by the sun and stars" (2020), no. 45.

617 On Nouet see the Wikipedia article in French, with a reference to a detailed study by Patrice Bret.

618 Bret, "Scientific instruments during the French Occupation of Egypt" (2019), pp. 127-129.

translation of their remarks *verbatim*, but the comments on instruments made by Muslim astronomers are my own. The largest sundial was horizontal:

> "The astronomer Tut [Nouet!] occupies the house of Ḥasan Kāshif Jirkis ("the Circassian"). In the upper courtyard of the house, he has drawn regular lines on the entire paved surface, in order to mark the hourly graduation until noon. Instead of a gnomon he has placed on the pediment of the house a circular plate, pierced by numerous holes, so that the sun's rays pass through them down to the lines and their divisions. Thus one can know the time up to noon, and which is the current sign of the zodiac, the images of which show the exact position of the sun every month."

(I am reminded of my friend, the Dutch astronomer-physicist Frans Bruin, who in the 1960s had a house with a flat roof in a village above Beirut. He made a hole in roof to receive the sun's rays, and followed the sun for almost four years with markings in chalk on the floor. Such markings over exactly four years would have enabled him to derive the length of the solar year without any instruments. Frans' mother-in-law came from Holland for a visit and, unfortunately for science, and before he could stop her, she had cleaned up the mess on the floor.)

A vertical, mural dial was fixed by Nouet in a more visible place in 1798 or 1799. It indicated hours from 6.30 a.m. to 6 p.m., as a painting by Conte also shows.[619] It is curious that al-Jabartī does not mention that vertical sundials of this same kind were common in Cairo mosques at the time. Indeed, the only mosque sundials remaining in Cairo mosques today are simple Ottoman-type dials mainly showing the time relative to midday. The historian continues (my emphasis):

> "(Nouet) also built, on the highest wall of the ground floor courtyard between the two houses, a dial with a gnomon to indicate the hours before and after the middle of the day. But **that dial is not like our dials which indicate the time of the ʿ*aṣr* (afternoon prayer), the hourly**

[619] *Description de l'Égypte*, É.M., I, pl. 60 / p. 630.

graduations until sunset, the twilight and dawn curves, the direction (*samt*) of the *qibla*, with the divisions in degrees, *etc*., in order to determine times of prayer. Since the French are not affected by those indications, they do not care about them."

Here there is some confusion, not least because a vertical sundial cannot show the *qibla*, unless of course, as was often the case, it was fixed on a wall of a mosque oriented toward the *qibla*. Sets of tables were available for marking a vertical sundial on a wall oriented at 53° west of the southern meridian, that is, toward 37° S of E, the *qibla*-value computed for Cairo by Ibn Yūnus eight centuries earlier. Even Ḥasan al-Jabartī compiled such a subset. A complete set of such tables for each degree of inclination to the meridian was compiled by the astronomer Shihāb al-Dīn al-Maqsī in Cairo in the late 13th century.[620] Further, Islamic sundials, horizontal and vertical, show the time of the *ʿaṣr* prayer. See, for example, the fine example made in 1296/97 for the Mosque of Ibn Ṭūlūn and illustrated in the *Description de l'Égypte* – **Pl. S10**.[621] On the other hand, only a few Islamic sundials, of the horizontal variety, would have shown time past since daybreak and time remaining until nightfall. The magnificent sundial of Ibn al-Shāṭir of Damascus, dated 1371, shows all of these features, including the gnomon aligned with the celestial pole.[622]

Lastly, in the garden of the Institut, al-Jabartī records a third sundial, this time a horizontal one:

"The same astronomer has also drawn many lines on the surface of a square plate of brass. He has put that plate on a column slightly shorter

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620 See *Cairo Survey*, no. C15, and King, "Astronomy of the Mamluks" (1983), p. 548.

621 Described in Louis Janin & David King, "Le cadran solaire de la mosquée d'Ibn Ṭūlūn au Caire" (1976).

622 See the descriptions in Janin, "Le cadran solaire de la Mosquée Umayyade à Damas" (1972), and King, *In Synchrony with the Heavens*, vol. 2 (2005), pp. 712-715.

> than the height of a man in the middle of the garden. The gnomon is in the form of an iron triangle, the shadow of which is projected down to the lines which are divided into degrees. It is quite a nice piece, bearing all the required indications on its border. The maker's name is written in Arabic in fine lettering, engraved on the copper and decorated with silver inlay."

al-Jabartī might not have known that the triangular gnomon, with the hypotenuse pointing toward the celestial pole, was an Arab invention, not, as is thought by most sundial enthusiasts to this day, a European invention; it attested already on the sundial of Ibn al-Shāṭir – see above. Nouet's sundial is the only one still existing of the three described by al-Jabartī, having been auctioned in London in 2007.[623]

This brief account hardly does justice to the remarkable variet and sophistication of the French instruments. The interested reader should consult Patrice Bret's writings. He concludes the paper we have cited with these words:[624]

> "Thus the Western scientific instruments brought by Napoleon's scientists as well as other technological items, indirectly assisted in increasing the consciousness of their importance in society, thus contributing to the rise of the Egyptian *Nahḍa* (Renaissance) and a modernizing spirit in the Near East, which had first slowly begun around the centre of power in Istanbul."

Some Islamic instruments the French did not see until 1994

Ibn Yūnus' monumental *Ḥākimī Zīj* was being investigated in Paris around 1800, as was al-Marrākushī's treatise on spherical astronomy and instrumentation shortly thereafter. Add to that the mind-boggling array of astronomical tables of one sort or another which had no counterpart

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[623] This sundial was sold at the auction "Art of the Islamic and Indian Worlds" at Christie's in London on April 17, 2007 – see www.christies.com/lotfinder/lot/a-napoleonic-brass-sundial-made-by-nicholas-4892277-details.aspx.

[624] Bret, "Scientific instruments during the French Occupation of Egypt, 1798-1801" (2019), p. 228.

anywhere else in the Muslim world or in Europe. Aspects of astronomy, such as gnomonics, the theory and construction of sundials, and astronomical timekeeping, had been, thanks to various Egyptian *lumières*, more advanced in medieval Cairo than in contemporaneous Europe. Only one medieval Egyptian sundial and one standard astrolabe feature in the *Description de l'Égypte* – **Pls. S10 & S13**.

The sundial was first studied in the 1970s by the French specialist on gnomonics, Louis Janin (1897-1978),[625] and the present writer. It is a fine and ingenious piece.

The astrolabe, of Andalusī or Maghribī provenance, was acquired in Cairo by Jean-Joseph Marcel (1776-1854), orientalist and director of the new Printing Press in Cairo, who intended to include an account of it in the *Description de l'Égypte*, as he included a detailed account of the Nilometer. However, this did not happen, perhaps because it was realized that the instrument had nothing to do with Egypt except the fact that someone had brought it there and he found it there. At some stage it was stolen from Marcel, apparently after he had brought it back to France. It has never been since.

The astrolabe was first described by Sédillot-*fils* in 1844 in his notes about the treatise of al-Marrākushī. These were summarized by Robert Gunther (1869-1940), founder of the Museum of the History of Science in Oxford, in his 1932 *Astrolabes of the World*, and again by his late successor in Oxford, Francis Maddison (1927-2006), appropriately in a 1987 reprint of selected images from *Description de l'Égypte*.[626] A dating to the 13th century has been proposed by Sédillot, but Western Islamic astrolabes are notoriously difficult to date. The Andalusī provenance is suggested not only by the inclusion of Andalusī place-names on the plates, but, strange

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625 See the obituary and list of Janin's publications in www.academia.e—*—du/38149206/.

626 For references see n. 599.

as it may seem, by the inclusion of (irrelevant) faraway places like Ikhlat and Azerbaijan. These are found on various 11th-century Andalusī astrolabes.[627] The Maghribī provenance is suggested only by the fact that Maghribī astrolabists included features from Andalusī astrolabes, including names of places in the former al-Andalus which had long since experiencd the *reconquista*.

In particular, Ibn al-Sarrāj's spectacular quintuply-universal astrolabe, made in Aleppo in 1328/29, and by far the most sophisticated astrolabe ever made,[628] was in Cairo from the early 15th century onwards. We know this from four dated inscriptions on the rim by a series of very serious owners:[629]

> (1) al-Kawm al-Rīshī, 1426/27, *muwaqqit* at the Mosque of al-Mu'ayyad in Cairo, who prepared a version of Ibn al-Shāṭir's Damascus *Zīj* for Cairo;
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> (2) ʿAbd al-ʿAzīz al-Wafā'ī, 1450/51, also *muwaqqit* at the al-Mu'ayyad Mosque in Cairo, who wrote numerous treatises on important instruments, and a brilliant treatise on the ways to use every component of this particular one;
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> (3) Ibn Abi 'l-Fatḥ al-Ṣūfī, 1510, the leading astronomer in Egypt in his time, not associated with any institution, who prepared a version of Ulugh Beg's Samarqand *Zīj* for Cairo, and who wrote the biography of Ibn Yūnus on the title folio of the Leiden manuscript of the *Ḥākimī Zīj*; and

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627 See King, *Synchrony*, vol. 2 (2005), pp. 952-956.

628 On this astrolabe see the references in n. 598. For a brief account see King, "Astronomy of the Mamluks" (1983), p. 546.

629 On these inscriptions see King, *Synchrony*, vol. 2 (2005), pp. 699-700. On the three owners before 1500 see "Astronomy of the Mamluks" (1983), pp. 553-554, and *Cairo Survey*, nos. C41, C61 & C98, and on the fourth *ibid*., no. D120.

(4) ʿAlī al-Khashshāb, 1856/57, *muwaqqit* in at the Baḥrī Mosque in Damietta, author of some astronomical works including a determination of the *qibla*s at Cairo and London, and owner of numerous astronomical manuscripts.

This instrument was wisely not shown to the French – we do not know who owned it *ca*. 1800 – , for they would have certainly, and wisely, requisitioned it. And, had they done so, it is so complex, that without the treatise of al-Wafā'ī, they might still be working on deciphering it.

The astrolabe of Ibn al-Sarrāj and the sundial of Ibn al-Shāṭir, together with eight other instruments from Damascus, but also from Cairo, were brought to the Institut du monde Arabe in Paris in 1994 for the spectacular exhibition "Syrie, Mémoire et civilisation".[630] No other country of the Islamic world has been so honoured. It was abundantly clear that astronomy in Syria in the 14th century reached unheard-of heights. The exhibition was supposed to go to Damascus from Paris, but the Syrian Government chose to deny the Syrian public from witnessing the greatest exhibition ever organized around civilization in ancient and medieval Syria.

Edward Lane and the *qibliyya*s in the early 19th century

The astronomical scene in Cairo as described by the English orientalist Edward Lane in the 1830s appears pathetic indeed, but Lane was obviously quite innocent of what Egyptian astronomers were up to in his time.[631] He wrote:

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630 Sophie Cluzan & Eric Delpont & Jeanne Mouliérac, eds., *Syrie, Mémoire et Civilisation*, 1993; this contains an essay "L'astronomie en Syrie à l'époque islamique" and a catalogue "Instruments astronomiques syriens".

631 Lane, *Manners and customs of the Modern Egyptians*, p. 220 (1987 edn.).

> "Telescopes are rarely seen here; and the magnetic needle is seldom employed, except to discover the direction of Mekkeh, for which purpose convenient little compasses (called *kibleeye*s), showing the direction of the *kibleh* at various large towns in different countries, are constructed, mostly at Dimyát: many of these have a dial, which shows the time of noon, and also that of the *'asr* [mid-afternoon prayer], at different places and different seasons."

If Lane had seen any telescopes in Egypt, they would certainly have been of European origin. But it is not a little ironic that it was in medieval Egypt that the magnetic compass was used for the first time as a serious scientific instrument and that the first estimate of magnetic deviation was achieved.[632] Extensive non-European, that is, Islamic tables for finding solar, lunar and planetary positions and for astronomical timekeeping and regulating the times of prayer would still have been in circulation in Lane's time, but he would not have been in a position to understand them anyway.

Renewed interest in astronomy in late Ottoman Egypt

> " ... scholarly astronomy contained more than its intersections with Islamic ritual; when scholars used a *zīj* like the *Brilliancy* (= *al-Lumʿa*, that is, the *Zīj* of the 15th-century Cairo scholar Shihāb al-Dīn al-Kawm al-Rīshī) to calculate prayer times or the beginning of Ramadan, they did so as part of a larger set of practices that measured and interpreted time in late Ottoman society." Daniel

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On simple devices for finding the *qibla* see already King, *World-maps for finding the direction of Mecca* (1999), pp. 100-124, and on Lane's comments see *ibid*., p. 122, n. 150.

Substantial collections of *qibla*-compasses are preserved in the Khalili Collection of Islamic Art, London; the National Maritime Museum in Haifa, and the Rautenstrauch-Joest-Museum at Cologne. As far as I am aware, only the last of these collections is catalogued: see Stautz, "Max von Oppenheim's Instrumente", A-B.

632 Schmidl, "Two early Arabic sources on the magnetic compass" (1997-98).

Stolz, *The Lighthouse and the Observatory* (2018), p. 27. (One would not use a *zīj* to calculate prayer-times in a location where tables displaying the prayer times had been available for some 900 years. Nor would one necessarily need a *zīj* to calculate crescent visibility when this is displayed for each month in every ephemeris. No comprehensive history of Ottoman timekeeping is available; sundials and clocks provide only part of the story.)

The vibrant scene of Fatimid and Mamluk astronomy continued during the Ottoman period even though Lane and everybody else amongst the Europeans in Cairo apparently had no idea about it.

This is not the place to dwell on this Ottoman tradition, for the introductory literature is more than adequate. I refer to the excellent discussion by the American historian of the Near East, Daniel A. Stolz, in his 2018 book *The Lighthouse and the Observatory*.[633] It deals with astronomy in late Ottoman Egypt, and its only shortcoming is that there is no book on Fatimid and Mamluk astronomy to precede it! (Whose fault is that?) Since Stolz, whose entire book is based on the appropriate primary sources, deals with the way the determination of the prayer-times and of the determination of the crescent were "modernized" in the 19th century, I should have been happy to see just a paragraph on each activity in earlier centuries.

It should be mentioned that there is nothing "wrong" with the tables for the prayer-times that had been used in Cairo for centuries. The problem is how one measures the time of day and night. Before the clock and watch one could read the exact time of prayer from a table accurately to within a few seconds, but what was one to do with that information? With clocks and watches the problem is basically resolved. However, the medieval tables gave time in equatorial degrees and minutes, where 1° corresponds to four minutes of an hour (24 hours involve a complete rotation of 360°).

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[633] See Stolz, "Positioning the watch hand" (2015) and *The Lighthouse and the Observatory* (2018) on aspects of astronomy in Ottoman Egypt.

The Ottoman tables were modified to display time in hours and minutes according to the Ottoman convention that sunset was 12 o'clock. The French also had to persuade the Egyptians that that unhappy convention should be abandoned too.

Stolz takes as an example of the astronomy of the period a work by a little-known author of the mid 19th century. This is Muḥammad al-Khuḍrī,[634] who wrote a commentary on the early-15th-century reworking by the Cairo *muwaqqit* Shihāb al-Dīn al-Kawm al-Rīshī of the mid-14th-century Damascus *Zīj* of Ibn al-Shāṭir. There are over 200 references to al-Khuḍrī in Stolz' book. Actually, the works of Ibn al-Shāṭir and al-Kawm al-Rīshī are in themselves probably worth a doctoral thesis, but the recent discovery that Ibn al-Shāṭir's "new" solar, lunar and planetary models came to Europe *via* Istanbul and Pavia rather than *via* Rome is more likely to generate interest, rather than these Arabic works themselves, inevitably still unpublished and not investigated in detail. al-Khuḍrī's work, of which there are at least a dozen copies in Cairo alone, plus an abridgement, is very much the end of a *cul-de-sac*.

Also in 2018, there appeared a book by the German U.S./Qatar-based science historian Jörg Matthias Determann presenting the next phase of astronomy in the Arab world,[635] with considerable emphasis on Egypt. Here nothing of consequence is mentioned of the history of Islamic astronomy, although kindly four specialists in that subject – Ted Kennedy and three of his academic offspring (Dallal & King & Saliba) – are briefly mentioned. Rather, the author jumps into the almost modern Near East and concentrates on the ways in which Arab astronomers and astronauts contributed to 'space science'. The book, probably the first overview of modern astronomy in the Near East, is well documented with primary and

634 *Cairo Survey*, no. D111.

635 Determann, *Space Science and the Arab World: Astronauts, Observatories and Nationalism* (2018).

secondary sources, even if lacking a background introduction that most potential readers would probably appreciate.

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A one-day symposium entitled "Fustat and the World in the Year 1000" held at the Bard Graduate College in New York City on 06.11.2015 dealt with "the ideological bases and political practices of the Fatimid state, as well as the widely dispersed objects, motifs and techniques associated with the Fatimid caliphate that became the courtly style par excellence of the medieval Mediterranean".[636] Ibn Yūnus worked in Fustat in the year 1000 and as an astronomer had no rival anywhere in the world at the time. I bet he was not mentioned.

The organizers of the October 2019 Summer School of the Union Européenne des Arabisants et Islamisants to be held at the Cà Foscari University in Venice and entitled "Mapping the Urban: Cities in Arabic Literature, Culture, and Society" expressed no interest in the present study (or at least could not be bothered to respond to a proposal to involve students).[637]

Conferences are now held on Mamluk Studies, but the last thing you will hear about is theory or practice of science, technology or medicine in Mamluk society.[638] We await with anticipation a publication on the Fatimids which mentions the scientific tradition in Cairo-Fustat and/or on the Mamluks which mentions the scientific tradition in Cairo.[639] Indeed,

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636 www.bgc.bard.edu/research-forum/articles/145/fustat-and-the-world-in.

637 http://arabic-philologies.de/venedig2019.html.

638 See, for example, Stephan Conermann, ed., *Ubi sumus? Quo vademus? Mamluk Studies – State of the Art* (2013).

639 The exhibition catalogue listed as Melikian-Chirvani, ed., *The World of the Fatimids* (2018), mentions neither.

The 1998 Paris colloquium on the Fatimids organized by Marianne Barrucand may have been the first and the last to have included astronomy, *qibla* and wind-

we should welcome any announcement of the fact that there was a tradition of astronomy in Egypt between the age of the Pharaohs and the arrival of the French.

I conclude that historians will continue to debate about astronomy in late Ottoman Egypt, but nobody thus far has viewed it in the light of what went before, which was pretty impressive. I confess to have been more interested in early works whilst cataloguing the Cairo scientific manuscripts and there was a reason why I worked on astronomical instruments "before 1500".

(Notes on the history of the history of Mamluk astronomical texts)

> " ... ... Others wrote about "Ottoman decline", some connecting the decline of science with prejudices among theologians. David King has blamed the Mongol invasion for the decline of astronomy." Avner Ben-Zaken, "Political economy and scientific activity in the Ottoman Empire" (2002), p. 778. (A reference leads to King, "Astronomy of the Mamluks" (1983), p. 551, where I wrote "Creative astronomical activity came to an end in Syria with the destruction of Damascus by the Mongols in 1402, in Egypt with the works of Sibṭ al-Māridīnī around 1500.")

The Mamluk astronomers in general and *muwaqqit*s in particular have had an interesting history in the modern literature and I record some of it here.

The fundamental bio-bibliographical works of Heinrich Suter and Carl Brockelmann and the derivative but important work of George Sarton contain numerous references to individual Mamluk astronomers, not a few

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catchers. In retrospect it is curious that Marianne, who oversaw the DEA (*diplôme d'études approfondies*) project of Olivier Jaubert, did not mention his work to me at the Paris colloquium, not least because I wrote about the wind-catchers for her colloquium proceedings without citing his work (because it came to my attention only in 2004).

of whom bore the title *muwaqqit*, indicating that they were affiliated with a religious institution. The activities of the *muwaqqit*s were mentioned in **a several sentences** in the groundbreaking work *The Observatory in Islam* (1960) by the Turkish scholar Aydın Sayılı, who was, of course, well aware that many serious astronomers bore that epithet. In the first survey of Mamluk astronomy which I published in 1983 I devoted **a single page** to the *muwaqqit*s. I presented there a list of 75 Mamluk astronomers, of whom 15 were *muwaqqit*s. To be fair to myself, I had already published detailed accounts of their major productions (tables and instruments), which were impressive indeed, and were of such a nature that they had no counterparts in Europe for centuries.

My late colleague, the Egyptian American historian of Islamic science and philosophy, A. I. Sabra, known as "Bashi" to his friends, visited us in Egypt and came with me to the Egyptian National Library. He was sceptical about whether *muwaqqit*s as mosque officials could achieve anything serious and later unfortunately made some ill-advised remarks about them and their non-achievements in various papers dealing with more philosophical aspects of Islamic science (where technical achievements are of no consequence). I dedicated to Bashi in 1995 a paper of **60 pages** dealing with all known aspects of the activities and productions of the *muwaqqit*s. In 2003 François Charette published a book of **550 pages** on the anonymous Mamluk treatise on 100 different instrument types, showing that the author was the Cairene astronomer Najm al-Dīn al-Miṣrī (not his contemporary Ibn al-Sarrāj as had been previously suggested).

In 2004 I published descriptions of hundreds of Islamic tables for timekeeping in a text of some **500 pages** (not all by Cairene *muwaqqit*s). In 2008, my colleague Sonja Brentjes kindly dedicated to me a **20-page paper** of the social aspects of the *muwaqqit*s from biographical dictionaries, which mention all sorts of people who never 'published', but which do not refer to their technical achievements or productions.

Most recently, the Belgian Mamlukologist, Fien De Block, has published a series of minor papers in which the basic features of the tradition of *muwaqqit*s in Mamluk society are confused. There are problems with

terminology, such as referring to astronomical handbooks with extensive tables (*zīj*es) as 'instruments' and as 'manuals for timekeeping' (*zīj*es have nothing to with instruments and they have very little to with timekeeping). The real 'manuals for timekeeping' and heaps of tables used by every *muwaqqit* and every savvy *muezzin* and the real instruments of their professions are not mentioned. There is a tendency to ignore, underestimate or criticize previous studies (which is always risky for beginners), and one should rather proceed with caution than throw it to the wind. So many source materials are available and so few workers with a sense of history and the double skills of Arabic and mathematics that every one is to be encouraged. In her recent doctoral thesis, Fien De Block boldly confronted a highly complicated astrological history of the campaigns of the Mamluks against the Ottomans which survives in a very problematic Cairo manuscript, thereby illustrating both the importance of codicological skills, the scope of Mamluk interests in astronomy and astrology, and the potential of Mamluk (pseudo-)scientific literature even for regional history as well as cultural history.

(14 — Excursus: Two traditions for finding the *qibla*)

قد نرى تقلب وجهك في السماء فنولينك قبلة ترضاها
فول وجهك شطر المسجد الحرام وحيث ما كنتم فولوا وجوهكم شطره

> "We (God) may see the turning of thy face (in confusion and seeking guidance) to the Heavens. So We shall indeed turn thee toward a (sacred) direction (*qibla*) that shall please thee. So turn thy face toward the sacred Mosque: wherever ye may be, turn your faces toward it." *Qur'ān* II.144.

> "Every challenge calls for the right men. ... ... When (some people) were asked to determine the direction of the *qibla* they were perplexed, because the solution of this problem was beyond their scientific powers. You see that they have been discussing completely irrelevant phenomena, like the directions from which the winds blow, and the rising points of the lunar mansions. Even the professional astronomers find it a difficult problem to solve, and so you can well imagine how difficult it is for the non-astronomer. ... ." al-Bīrūnī (*ca*. 1025), in his *Taḥdīd nihāyāt al-amākin*, translated by Jamil Ali (1966), p. 12.

The subject of the *qibla* or sacred direction toward the sacred Kaʿba is discussed in numerous studies. Amongst much that is serious one finds also much that is pietistic or based on wishful thinking. As if by a miracle, the deficient article "Qibla" that was to be found on Wikipedia in 2019 was updated by an anonymous editor and replaced by a much more accurate one in mid 2020.

As an example of a scholarly study of the application of the *qibla* in the earliest mosques, I mention the 2010 Leeds University doctoral thesis of Essam Ayyad, currently Professor of Islamic Studies at Qatar University. Entitled *The influence of Ḥadīth on the architecture of early congregational mosques*, this is an important study, organizing and

evaluating much material on the early *qibla*.[640] On the determination of the *qibla*, the author tends to accept medieval or modern commentators who say that this or that *qibla* was incorrect. One of these moderns, a Spanish historian of Islamic art, still thinks that the Great Mosque of Cordóba faces due south, as it did for Creswell.

We shall not dwell on any of this because it is more important to find out what the Muslims who built the first mosques thought they were doing when they laid out a mosque in a specific direction. One thing is for sure they did not lay them out in the (modern) direction of Mecca (or anywhere else). **The *qibla* is toward the sacred Kaʿba, not toward Mecca.** Fortunately, we have medieval texts which tell us in same cases not only what they thought they were doing, but also what they did. All of their procedures involved astronomy in one way or another. Those which involved folk astronomy involve the orientation of the Kaʿba, which was laid out at an unknown time long before the advent of Islam.

The dichotomy of Islamic astronomy, practiced in two virtually independent ways, or at two different levels, each for well over a millennium, is well reflected, perhaps even best reflected, in the way Muslims over the centuries have sought to determine the sacred direction. These can be simplistically characterized as finding the direction of the Kaʿba on the one hand, and calculating the direction of Mecca on the other. The difference is more significant than one might at first imagine. Before we turn to the situation in Cairo, we consider each tradition separately.

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[640] Essam Ayyad, *The influence of Ḥadīth on the architecture of early congregational mosques*, PhD thesis, Institute of Medieval Studies, University of Leeds, 2010, at www.academia.edu/10411415/.

Sacred geography for finding the direction of the Kaʿba

Finding the *qibla* by the sun and stars

... وبالنجم هم يهتدون ..., " ... and by the star(s) they (Man) will be guided. ... " *Qur'ān* XVI.16.

> "The direction of prayer around which the people of the world are placed, as it were, in concentric circles has been and still is the most visible sign of the unity of the Muslims; it is, so to speak, the spatialization of their belief in one, and only one, God." Annemarie Schimmel, "Sacred geography in Islam" (1991), p. 164.

> "References to the Kaʿba throughout the Qur'ān, *ḥadīth* (sayings of the prophet), *tafsīr* (Qur'ānic exegesis), and *qiṣaṣ al-anbiyā'* (stories of the prophets) establish the significant role it plays in the physical and cosmological orientation of Islam. A study of these references reveals three roles that the Kaʿba plays in the theme of identity building and narrative adaptation. The first is the role of the Kaʿba as a spiritual nexus mirroring the eternal. The second is the role of the Kaʿba as a spiritual tie through all generations. The third is the role of the Kaʿba as a renewal of posterity and connection with God." Ben Priest, "The Kaʿba and Islamic Identity" (n.d.), at www.academia.edu/13589200/. (The fourth role as centre of the world in (medieval) sacred geography came later and was a natural extension of the first three.)

The expression "sacred geography" in the context of historical Islam was, I believe, introduced in 1991 by the renowned German orientalist Annemarie Schimmel (1922-2003), who dealt mainly with spiritual and mystic themes, veritably, the geography of a *ṣūfī* mystic and a poet.[641] The

[641] Schimmel, "Sacred geography in Islam" (1991).

expression could also be applied to the descriptive and pictorial geography of the various religious sites immediately around the Kaʿba.[642]

What I mean here and elsewhere by this expression is something quite different and fairly new to the modern literature on Islamic history. I refer to the ways Muslims conceived to divide the world into sectors around the Kaʿba and to associate each sector with a segment of the perimeter of the edifice. For each sector the *qibla* was the direction, usually astronomically defined, in which one would be standing if one were standing directly in front of that segment of the perimeter. This tradition has a history of well over a thousand years, and the first serious mention of it in the modern literature appeared around 1980. (Although the first known schemes of this kind date from the 9th century, we can be sure the underlying idea was known earlier, because the earliest mosques from the 7th and 8th centuries and indeed the Kaʿba itself attest to the use of astronomical alignments. Such alignments were used in Arabia in the centuries before Islam, notably by the Nabataeans.[643])

The *qibla* can be approached from a multiplicity of different aspects. But it has seldom been taken as seriously by historians as it should have been. We shall here refrain from a discussion of Jerusalem as the first *qibla*,[644]

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642 See, for example, Ettinghausen, "Die bildliche Darstellung der Kaʿba im islamischen Kulturkreis" (1933), and Milstein, "Futuh-i Haramayn: 16th-century illustrations of the Hajj route" (2006).

643 See, most recently, Belmonte *et al*., "Equinox in Petra: Land- and Skyscape in the Nabataean Capital" (2020).

644 See, for example, Neuwirth, "From the Sacred Mosque to the Remote Temple" (2003); also Saifullah & Ghoniem & Squires & Ahmed, "The Qibla of early mosques: Jerusalem or Makkah?"' (2001).

and from any comparison with customs relating to the sacred direction in other prevailing religions.[645]

The astronomical orientation of the Kaʿba

> "The Kaʿba is the *qibla* for the Sacred Mosque, the Sacred Mosque is the *qibla* for the sacred precincts (of Mecca and its environs), and the sacred precincts are the *qibla* for the inhabitants of the whole world from where the sun rises to where it sets." Ibn al-Qāṣṣ (*ca*. 975).

> "The Kaʿba with respect to the inhabited parts of of the world is like the centre of a circle with respect to the circle itself. All regions face the Kaʿba, surrounding it as a circle surrounds its centre, and each region faces a particular part of the Kaʿba." al-Maqrīzī, *al-Khiṭaṭ*, I, 257-258.

One of the reasons why this sacred geography developed as it did was that the rectangular base of the Kaʿba itself – **Pls. U9 & U10 & U7** – is astronomically aligned. Its corners roughly face the cardinal directions and that is well known. However, the Kaʿba has other significant directions, which were known centuries ago to the initiated and which underlay much of later sacred geography.

The base of the Kaʿba is rectangular, its axes being in the ratio 8:7. This ratio is adequate to ensure that to an observer the edifice looks rectanguloid, rather than cuboid. The main axis of the Kaʿba points toward the rising of Canopus, the brightest star in the southern sky, and the setting of the stars of the Plough; its minor axis points toward summer sunrise and winter sunset – for the latitude of Mecca these two directions happen to be more or less perpendicular. Canopus is, after Sirius, the brightest star in

645 The doctoral dissertation by Ari Michael Gordon, *Sacred orientation: The Qibla as ritual, metaphor, and identity marker in early Islam,* University of Pennsylvania, 2018, contains important new materials and insights.

the southern sky; it served as south-indicator because it rises and sets in northern tropical latitudes fairly close to the true south. The stars of the Plough, which served as a north-indicator, do indeed rise and set at the latitude of Mecca.[646] These orientations are shown in **Pl. T1**. An alignment with a lunar extremity, which was also found, is not significant, given the relative crudity of the roughly rectangular plan of the edifice.

These orientations may sound complicated to those outside the field of archaeoastronomy, but they are in fact very simple and can indeed be expressed in a simpler fashion. We can say, for example, that the major axis is aligned towards the rising of Canopus; the rest follows. Or we can say the minor axis is aligned toward summer sunrise; the rest follows. What was originally intended when the Kaʿba was first built as a pagan shrine or a Semitic *beytel*, "house of God", we shall never know.

This information about the orientation of the Kaʿba was first rediscovered in modern times in the writings of the 13th-century Yemeni astronomer Muḥammad ibn Abī Bakr al-Fārisī from Aden, a man well versed in both mathematical astronomy and folk astronomy.[647] A translation of his statement in his treatise on folk astronomy entitled تحفة الراغب وترفة الطالب في تيسير النيرين وحركات الكواكب, *Tuḥfat al-rāghib wa-turfat al-ṭālib fī taysīr*

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646 The stars of the Plough or Great Dipper (U.S.) are discussed in the article "Nudjūm (stars)" in *Enc. Islam*, 2nd edn., by the late Paul Kunitzsch (1930-2020), the world's leading expert on the stars in Islamic civilization, but the star سهيل , *Suhayl*, or Canopus, is nowhere mentioned in the entire *Encyclopaedia*.

647 On al-Fārisī see King, *Astronomy in Yemen* (1983), pp. 23-26, esp. pp. 23-24; and Schmidl, *Volkstümliche Astronomie* (2007), I, pp. 18-27.

On this text see King & Hawkins, "The Orientation of the Kaʿba" (1982), pp. 103-105, with an illustration of the extract from the Milan manuscript, and Schmidl, *op*. *cit*. One of the few scholars to have mentioned the Canopus connection is Anton Heinen (1939-1998) in his brilliant essay "Geographical investigations under the guidance of Islam" (2003).

al-nayyirayn wa-ḥarakāt al-kawākib, extant in the unique copy MS Milan Ambrosiana X73 sup. (Griffini 37), unfoliated, reads:

> الباب الحادي عشر في معرفة جهات القبلة من الكعبة المعظمة والاستدلال عليها في جميع الاقاليم اعلم ان الاستدلال على القبلة قد يكون بالرياح والنجوم اما النجوم فمن خصائص الليل والريح مشترك بينهما فاول ذلك معرفة مهب الرياح وهي اربعة يقابل كل ريح منها ركنا من اركان البيت فما سوا هذه الرياح يسمى نكباء اولها الصبا وهي الشرقية من البيت وهي تقابل من الركن الاسود الى الركن اليماني ومهبها من مطلع الشمس الى مطلع سهيل وثانيها الجنوب وهي اليمانية ومهبها من مطلع سهيل الى مغرب الشمس وثالثها الدبور وهي الغربية ومهبها من مغرب الشمس الى بنات نعش ورابعها الشمالية وهي شامية ومهبها من بنات نعش الى مطلع الشمس ...
>
> "Chapter 11 on knowing the directions of the *qibla* with respect to the exalted Kaʿba and being guided towards it in all regions. Know that finding the *qibla* may be by means of the winds or by means of the stars, although the stars can be used only by night and the winds can be used by both night and day. **On the knowledge of the places from which the winds blow.** (The winds) are four (in number), and each one faces a corner of the Kaʿba. Other winds in between are called *nakbā'* (intermediary winds). The first of the winds is the ***ṣabā***, which is easterly of the Kaʿba, facing (the wall between) the Black Stone and the southern corner, and it blows from between (summer) sunrise and the rising point of Canopus. The second is the ***janūb*** which is southerly, and it blows from between the rising point of Canopus to the (winter sunset). The third one is the ***dabūr*** which is westerly, and it blows from between (winter) sunset to (the setting point of) the three stars of the handle of the Plough (*banāt naʿsh*). The fourth one is the ***shamāl*** which is northerly, and it blows from between (the setting point of) those stars and (summer) sunrise."

The astronomical alignments of the Kaʿba implied in the text were confirmed by satellite images, taking into consideration the height of the hills around the city of Mecca. The question whether it was deliberately laid out to be astronomically aligned is easily answered but I leave it to others to investigate. It seems that the Kaʿba was laid out in a *wādī* which occasionally flooded, it rests on a roughly rectangular foundation in the direction of the *wādī*, which happened to be roughly south, more or less in the direction of the rising of Canopus. The rest follows.

The very distinctive orientation of the Kaʿba is now known to be mentioned in several other medieval sources. It would be naïve to think

that it has ever been changed over the centuries; additional proof that it has not is provided by the fact that the corners still roughly face the cardinal directions and the low semi-circular wall (الحجر, *al-ḥijr*) attached to the NW Wall would have had to have been rebuilt if the Kaʿba had ever been rebuilt to face different directions.

The earliest recorded statement about the limits of the four main winds (*shamāl*, *ṣabā*, *janūb* and *dabūr*) corresponding to the astronomically-defined directions which are elsewhere associated with the axes of the Kaʿba is attributed to the Ibn ʿAbbās (619-687/8), the celebrated companion of the Prophet Muḥammad.[648] Likewise, the earliest mention of an association between the four winds and the four sides of the Kaʿba is in a statement attributed to the celebrated religious personality Ḥasan al-Baṣrī (642-728).[649]

I see no reason to suspect that these traditions were deliberately fabricated (they serve no religious or sectarian or political purpose); rather, I see them as reflecting pre-Islamic Arab meteorological beliefs. Even the great scientist al-Bīrūnī mentions the association of the Kaʿba and the winds.[650] Certainly, there are no indications that such traditions were deliberately suppressed in later times. They appear in the genre of books called كتب العظمة, *kutub al-ʿaẓama*, dealing with the greatness of God as revealed by his creation, as well as lexicographical works and treatises dealing with

648 Heinen, *Islamic Cosmology: A Study of as-Suyūtī's al-Hay'a al-saniya fi-l-hay'a al-sunniyya* (1982), p. 158.

649 *Ibid*., p. 157.

650 al-Bīrūnī, *Tafhīm*, p. 19.

folk astronomy.[651] The very word قبلة , *qibla* may well be derived form one name of the east wind in Hejazi wind-schemes, name قبلة , *qabūl*.[652]

Some authors who obviously had never visited the Kaʿba and had little idea of geography were less well informed about its orientation. Thus, for example, the anonymous Egyptian author of a treatise on simple timekeeping متن اقرب الادلة, *matn aqrab al-adilla ...*), extant in MS Leiden UB Or. 2575 (fol. 2r),[653] wrote:

> الكعبة مربعة على وزانه (؟) فركن الحجر الاسود نقطة الشرق والعراقي نقطة المغرب واليماني نقطة الجنوب والشامي نقطة الشمال
>
> "The Kaʿba is square ... (?): the corner of the Black Stone is at the east point, the ʿIrāqī [*sic* for Western] corner at the west point, the Yemeni corner is at the south point, and the Syrian corner is at the north point."

The ʿIrāqī corner, of course, points toward the east, and it is the corner housing the Black Stone.

In a different guise these astro-meteorological associations of the Kaʿba also reappear in certain later Sufi texts. Consider, for example, one of the manuscript extracts in **Pl. U11**, which shows a diagram relating the orientation of the Kaʿba (incorrectly displayed) and the *qibla*s of four localities to the directions of the winds and the weather of the four seasons, using an Aristotelian-type configuration of two diagonally-superposed

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651 See Heinen, *Islamic Cosmology* (1982), and King, review of Heinen 1982 (1989), available at www.academia.edu/34693225/.

652 On the notion of Mecca as the navel of the earth see A. J. Wensinck, "The ideas of the Western Semites concerning the navel of the earth" (1916/1978). For some thoughts on the Kaʿba as a microcosm of the universe see King, "Astronomical alignments inmedieval Islamic religious architecture" (1982), pp. 308-309, using the important study by the French scholar of early Southern and Central Arabia and of the sociology of Islam, Joseph Chelhod (1919-1994), "A contribution to the problem of the pre-eminence of the Right, based upon Arabic evidence" (1973).

653 Witkam, *Inventory of the Oriental manuscripts in Leiden University Library*, III, p. 162.

squares which usually represent the elements and their qualities.[654] This illustration is found in an anonymous Sufi treatise on the Kaʿba and the *qibla* preserved in a late-18th-century Egyptian manuscript (MS Cairo Ṭalʿat *majāmīʿ* 811), but is clearly of much earlier origin.[655] The treatise, which is in Arabic, appears to be of Ottoman provenance; but although the Andalusī mystic Ibn al-ʿArabī (1165-1240) is mentioned in the preceding treatise,[656] I have not yet found any earlier references to this kind of representation of the Kaʿba.

Seldom are the different ways of finding the *qibla* mentioned together. An exception is the late-15th-century Omani navigator, Ibn Mājid, quoted above.[657] The four methods he proposes are: 1) using latitudes and longitudes; 2) using the Pole Star; 3) using the magnetic compass and a wind-rose of 32 equal divisions; and 4) using the wind-scheme associated with the Kaʿba, although, he says, this is less accurate than the other methods. (Ibn Mājid does not himself propose a scheme of sacred geography here, but he does criticise the 12-sector scheme of Ibn al-Wardī,

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654 For this kind of symbolism, I was able in 1984 to point the reader to Derek J. de Solla Price, *Science since Babylon* (1976 edn.), pp. 76-78. I have not pursued any more recent discussions.

655 On the Cairo manuscript see *Cairo Survey*, fig. XLVII on p. 267 and the caption on p. 206. The diagrams are discussed in King, “Astronomical alignments in medieval Islamic religious architecture” (1982), p. 308, and “Illustrations in Islamic scientific manuscripts” (1995), pp. 171-173.

656 On Ibn al-ʿArabī and the *qibla* see the references in n. 664.

657 On Ibn Mājid see the article “Ibn Mādjid” in Enc. Islam, 2nd edn., by Dominque Sourdel. On this poem see Ferrand, *Instructions nautiques et routiers arabes et portugais des XVème et XVIème siècles* ... (1921-28), I, pp. 209-211, *etc*. I owe this reference to the generosity of Farid Benfeghoul. On Arab navigation see also Tibbetts, *Arab navigation in the Indian Ocean before the coming of the Portuguese* (1971).

pointing out, for example, that China and Western India should not be in the same sector and that Ethiopia should not have a whole sector to itself.)

The association of the Kaʿba with the winds, the astronomical alignment of its sides, and the significance of the star Canopus are stressed by the current-day Muslim spokesman Shaykh Hamza Yusuf in a short video called "The Sacred City of Mecca" (2016).[658] There is no indication where he found this information, but it is now available in the Wikipedia article "Kaʿba".

[658] Shaykh Hamza Yusuf, "The Sacred City of Mecca" (2016), at www.youtube.com/watch?v=Yw-HCPFp674&feature=youtu.be. (3:42 mins.).

Important new publication: The British historian of Islamic art Simon O'Meara, is on the point of publishing a new book, the first book in a Western language ever devoted to different aspects of the historical Kaʿba. It is entitled *The Kaʿba Orientations – Readings in Islam's* Ancient House (or *The Kaaba of Mecca as Axis and Matrix Mundi*) and is published by Edinburgh University Press in 2020. At the time of uploading this monograph, I have not seen O'Meara's new study, which promises to present considerable new material and offer many new insights. The six chapters are entitled: 1) The Kaʿba as Qibla; 2) The Kaʿba as Navel; 3) The Kaʿba as Substructure; 4) The Kaʿba as Beloved; 5) The House as Holder; 6) The House as Dwelling. The author is correct in claiming that even though the Kaʿba is the most important edifice in the Islamic world, it is the one that has been most neglected by historians of Islamic architecture. As he says, "decolonisation of Islamic art history awaits completion".

See further the podcast at https://barakat.org/latest-news/episode-13-the-sanctuary-at-the-heart-of-islam-with-simon-omeara/ (accessed June, 2020).

The different schemes of the world about the Kaʿba

> "The inhabitants of al-Qadisiyya, Kufa, Baghdad, Hulwan, Hamadhan, Rayy, Nishapur, Marwarrudh, Khwarazm, Bukhara, Tashkent, Farghana, and localities lying in the same direction, face (the section of) the Kaʿba between the *Muṣallā* of Adam – may peace be upon Him – and its Door. So whoever is in one of those localities or in a line with them (and the Kaʿba) and wants to face the *qibla*, should have the Banāt Naʿsh (stars of the Plough) rising behind his right ear, (the lunar mansion) al-Hanʿa (rising) directly behind him, the Pole Star at his right shoulder, the East wind at his left shoulder, the North wind between the right side of his neck and the nape of his neck, the West wind at his right cheek, and the South wind at his left cheek. Anyone who uses one or some of these prescriptions in these localities or (others) in the same direction will be facing the (appropriate) section (*jiha*) of the Kaʿba." Ibn Surāqa (*ca*. 1000).

> "The science of star nomenclature, the appearances of the stars, their risings and settings, ..., the finding of the direction of the *qibla* by means of the stars, and the knowledge of the times of prayer and the hours of the night by the appearances and the settings of the stars." al-Khaṭīb al-Baghdādī, the 11th-century religious scholar and historian, outlining the acceptable aspects of astronomy in his treatise against astrology (slightly modified from Anton Heinen, *Islamic Cosmology* (1982), p. 25).

The legal scholars and the specialists on folk astronomy developed their own ways of facing the Kaʿba using astronomical alignments. They developed a set of schemes for finding the *qibla* without any calculation. It is important to keep in mind that the *qibla*s proposed by the Muslim legal scholars would be different from those proposed by the Muslim astronomers. Both sets would necessarily different from modern *qibla* values, which are based on modern geographical coordinates.

Earlier this year, 2019, I published for the first time the known sources for historical Islamic sacred geography, the notion of the world divided in sectors about the Kaʿba with the *qibla* of each sector defined in terms of

astronomical phenomena.[659] These sources, some 50 in number, had never been identified before, although their existence was first mentioned in the article "Makka as centre of the world" in the *Encyclopaedia of Islam* (1987). They were rediscovered during the 1970s and '80s mainly in previously-unstudied medieval Arabic scientific manuscripts in libraries around the world. Many more manuscripts of works on astronomy, folk astronomy, geography, sacred law, and encyclopedias, were searched for such materials with negative results. On the other hand, there are surely many more such sources that have not yet been located in manuscript libraries. See **Pls. T3-T6** and **U11** for some examples in which diagrams are presented; in other treatises, these schemes are laboriously described in words.

The texts and diagrams identified deal with a quite distinctive kind of **sacred geography**, or, should we say, **sacred folk geography**, involving a world divided in sectors around the Kaʿba. Each sector is associated with a segment of the perimeter of the Kaʿba and the *qibla* in each sector is the direction in which one stands in front of the Kaʿba facing that segment of its perimeter.

Several of the works cited belong to a class of literature that is little known nowadays. The genre was called كتب دلائل القبلة, *kutub dalāʾl al-qibla*, or books on the ways of finding the *qibla* by simple (non-scientific) means. Other works belong to the better-known genre كتب الانواء, *kutub al-anwāʾ*, dealing with the seasons and general folk astronomy.

Our sources on sacred geography contain two kinds of information:

- instructions on how to find the *qibla* using the risings and settings of the sun and certain *qibla*-stars (and in some cases, the winds) or the Pole Star for a specific region; or
- details in words or in diagrams on the way in which the medieval Islamic world was thought to be divided in sectors around the Kaʿba,

[659] King, "Finding the *qibla* by the sun and stars" (2019), and n. 524 above.

each sector associated with a segment of the perimeter of the edifice, with an associated *qibla* derived from the orientation of that wall-segment.

In spite of the considerable documentation already available, there seems to be some incredulity that *qibla*s were actually determined using astronomical risings and settings, not least because the historical mosque orientations, which are often curious to moderns, have persuaded some ill-informed writers to claim that the mosques were not oriented toward Mecca at all, but rather to some alternative cult-site. These authors overlook the fact that the *qibla* is toward the Kaʿba not toward Mecca – there is, as we shall see, a subtle difference. These authors, although they essentially seek to denigrate Islam, are not revisionists in the traditional sense because, having no idea about historical *qibla* determinations, they revise nothing; rather, they simply generate "false news" about the *qibla*.

The legal notions of *jiha* and *ʿayn*

As we shall see, different directions were used for the *qibla* in Egypt between the 7th and 15th centuries. The early-15th-century Egyptian historian al-Maqrīzī was upset by their divergence, but the legal scholars were in general less concerned and proposed a simple expedient. Several medieval legal treatises, as well as al-Maqrīzī in his discussion of the *qibla*s in Egypt, deal with the determination of the *qibla* by two non-mathematical methods, referred to as اصابة العين, *iṣābat al-ʿayn*, and اصابة الجهة, *iṣābat al-jiha*, literally, "aiming as if one could see" and "aiming by general direction", or simply as *ʿayn* and *jiha*.[661] These notions are clearly illustrated in **Pl. T3**, taken from the Oxford manuscript of al-Dimyāṭī's treatise (on which see below).

[661] See, for example, al-Qarāfī, *al-Dhakhīra*, I, pp. 489-508; and al-Maqrīzī, *Khiṭaṭ*, II, pp. 256-264, as well as the illustrations in the Oxford manuscript of al-Dimyāṭī's treatise – see below.

The essence of the first method is that one should stand in such a way that, if one could see the Kaʿba, one would be looking along a wall of the Kaʿba, that is, head-on toward the perpendicular wall. The essence of the second is that when one is standing in that direction, then the sector of the horizon which one can see, that is, roughly a quadrant, may serve as the *qibla*. The *qibla* directions prescribed for the first method are always in terms of astronomical risings and settings, equated with those that one would be facing if one were standing directly in front of the appropriate section of the perimeter of the Kaʿba. However, the *ʿayn* might be determined, the *jiha* would be the entire quadrant which was most appropriate. Thus in Egypt, as well as the Maghrib and al-Andalus,[662] the limits of the *jiha* were east and south, so that any *qibla* in the south-eastern quadrant would be legally acceptable according to those who favoured the *jiha* over the *ʿayn*.

Given the situation regarding *qibla* determinations by two distinct traditions this legal solution is eminently sensible. It was not first proposed by al-Dimyāṭī, for it is already described by no less a figure than the famous theologian al-Ghazālī (1058-1111).[663] Also the 13th-century Andalusī mystic Ibn al-ʿArabī[664] said the same thing:

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662 On the situation in the Maghrib see Bonine, "The sacred direction and city structure in Morocco'' (1990) and "Romans, astronomy and the *qibla*: urban form and orientation of Islamic cities of Tunisia" (2008); on the situation in al-Andalus and the Maghrib see Rius, *La Alquibla en al-Andalus y al-Magrib al-Aqsà* (2000); and on the special situation in Córdoba see King, "The enigmatic orientation of the Grand Mosque in Córdoba" (2019).

In fact, the principal historical mosques from Córdoba to Tunis, which all face roughly the same direction, were built according to the pre-existent Roman city-plans and are happily aligned with their *qibla*-walls 'parallel' to the north-west wall of the Kaʿba or their principal axes 'parallel' to its main axis.

663 al-Ghazālī, *Iḥyā' ʿulūm al-dīn*, section on the *qibla*.

664 On Ibn al-ʿArabī see the article in *Enc. Islam*, 2nd edn., by the Turkish scholar A. Ateş. Text quoted from Hoyrup, *Islam as seen by others* (1997), p. 567, after Ibn

“Scholars disagree as to whether one who is distant from the Kaʿba is obliged to turn to face the Kaʿba itself or in its general direction (*istiqbāl al-ʿayn aw istiqbāl al-jiha*). Some say: “His duty is to face the Kaʿba itself,” but this is weak, for it is a commandment (*taklīf*) to which one cannot attain. Some say: “In the general direction,” and this is correct.”

What some proponents of sacred geography maintained was that one could face the Kaʿba wherever one was situated by facing the same direction as one would be standing facing the appropriate segment of the perimeter of the Kaʿba. What our mystic omits is that one can also calculate the *qibla* if one has the necessary facilities. What he proposes, facing the general direction of the Kaʿba (استقبال الجهة, *istiqbāl al-jiha*), is a compromise, and the resulting mosque orientations often reflect this.

Mis-defining the *qibla*

An interesting error crept into the first edition of the *Encyclopaedia of Islam*, and persists in the new, third edition.[665] First, the Dutch orientalist Arent Jan Wensinck (1882-1939), author of many important articles in the *Encyclopaedia*, of which he was a founding editor, began the article “Ḳibla” with this definition:

“Ḳibla, the direction of Mecca (to be exact of the Kaʿba or the place between the water-spout (*mīzāb*) and the western corner), which has to be observed during the *ṣalāt* [prayer].”

In the third edition we read in the new article “Kaʿba” by the historian of the Islamic world, Harry Munt:

“The precise *qibla* is the section of the northwest wall between (the) *mīzāb*

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al-ʿArabī, *Aḥkâm al-Qur'ān*, I, pp. 42-43. See already n. 656 on Ibn al-ʿArabī and the Kaʿba.

665 Compare Arendt J. Wensinck, article “Ḳibla, Legal aspects” in *Enc. Islam*, 1st edn., vol. IV, p. 985, of the 1987 reprint, also *Enc. Islam*, 2nd edn., V, pp. 82-83, and Harry Munt, article “Kaʿba”, in *Enc. Islam THREE*.

and the western corner."

As they stand, in both versions, the statements are false. What has happened is, however, easily explained: Wensinck was quoting some medieval text, probably a legal one, in which the *qibla* was indeed so defined. But the text cited clearly contained just a fragment of a scheme of sacred geography, in which the perimeter of the Kaʿba was divided into a specific number of segments, each associated with a specific sector of the world. In other words, the statements are true but only for a certain sector (or group of regions) of the world.

I illustrated these divisions of the perimeter of the Kaʿba in various medieval sources in the article "Makka as centre of the world" in the 2nd edition of the *Encyclopaedia*. The scheme of sacred geography with 13 sectors in **Pl. T6** shows this segment of the perimeter of the Kaʿba associated with Upper and Lower Egypt, the Nile Delta, and Libya, so it was probably an Egyptian treatise that Wensinck was quoting. It was not uncommon that incomplete schemes of sacred geography were in circulation. Also curious is a tendency amongst certain modern scholars of Islamic architecture to claim that the *qibla* is toward the Black Stone. I have addressed this elsewhere.[666]

Mathematical methods for finding the direction of Mecca

> "Even the professional astronomers find the *qibla* problem difficult to solve, so you can imagine how difficult it is for non-astronomers." The great early-11th-century scientist al-Bīrūnī of Ghazna in his *Taḥdīd nihāyāt al-amākin*, the most important Muslim work on the mathematical determination of the *qibla*, transl. Jamil Ali (1966), pp. 11-12.

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[666] King, "The enigmatic orientation of the Grand Mosque of Córdoba" (2018-19), pp. 42 & 81.

The *qibla* as a problem of mathematical geography

Muslim astronomers from the 8th century onwards concerned themselves with the determination of the *qibla* as a problem of mathematical geography. This activity required knowledge of geographical coordinates and involved the computation of the direction of one locality from another by procedures of geometry or trigonometry, such as the analemma (a sophisticated device for reducing problems on a sphere from three dimensions to two) or spherical trigonometry. The reader will find more detailed accounts elsewhere.[667]

The *qibla* at any locality was defined as the direction to Mecca along the great-circle on the terrestrial sphere. The basic problem, illustrated in **Pl. T8**, is to determine the direction to Mecca M from any locality X, given the latitudes of both localities, measured by MB (= *b*) and XA (= *a*), and the longitude difference AB (= *c*). The *qibla* is measured by the angle AXM (= *q*). We shall also have occasion to use the latitude difference XD (= *a-b*) and the distance to Mecca XM (= *d*).

The earliest approximate methods

Once the geographical data are available, a mathematical procedure is necessary to determine the *qibla*. The first Muslim astronomers who considered this problem developed a series of approximate solutions, all adequate for most practical purposes. The approximate solutions were perhaps inspired by cartographic considerations. However, also in the early 9th century, accurate solutions by solid trigonometry and projection methods were formulated, and in the 10th century solutions by spherical trigonometry. Over the centuries one “standard approximate method” was generally advocated in popular treatises on astronomy, and the most

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667 For example, in the articles “Ḳibla” in *Enc. Islam*, 1st edn. and 2nd edn.; Berggren, *Episodes in the mathematics of medieval Islam* (1986), pp. 182-186.

widely-known exact procedure amongst the experts was the "method of the *zīj*es".

There is evidence that various scholars over the centuries favoured simple cartographic solutions to the *qibla* problem: in an anonymous treatise from 9th-century Baghdad three methods are presented (**Pl. T9**), together with an accurate solution by solid trigonometry and even a table displaying the *qibla* for a whole range of latitudes and longitudes.[668] The author, as yet unidentified, was clearly capable of considering the *qibla*-problem in both cartographic and mathematical terms. The approximate procedures he presents are equivalent to:

$$q = \tan^{-1}\{ c / (a-b) \},\ \tan^{-1}\{ c \cos b / (a-b) \},\ \tan^{-1}\{ \sin c \cos b / \sin c \}\ .$$

Only the first of these had any following in later centuries, namely, on maps with square cartographic grids on which a given locality was simply joined to Mecca by a straight line.

Another approximate method first attested in the early 9th century but possibly earlier lends itself to the simple geometrical construction shown in **Pl. T9/(3)**, and is equivalent to the formula:

$$q = \tan^{-1}\{ \sin c / \sin (a-b) \}\ .$$

This, the "standard approximate method", was widely used until the 19th century but was generally not approved by the more serious astronomers.[669]

Exact solutions to the *qibla* problem

The modern formula for the *qibla* is:

$$q = \cot^{-1}\{ [\cos c \sin a - \cos a \tan b] / \sin c \},$$

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[668] King, "Earliest Islamic methods and tables for finding the direction of Mecca" (1987/88).

[669] *Ibid*., pp. 103-107.

and various accurate solutions were devised by Muslim astronomers from the 9th century onwards which were mathematically equivalent to this although they usually involved various steps. The distance to Mecca was also of interest. It may be derived using:

$$d = \sin^{-1} \{ \sin c \cos b / \sin q \} .$$

As noted above, an anonymous astronomer in 9th-century Baghdad derived an accurate formula for the *qibla* by solid trigonometry, a remarkable and highly complicated achievement. From that century onwards, numerous Muslim scientists discussed the *qibla* problem, presenting other accurate solutions by spherical trigonometry, or reducing the three-dimensional problem to two dimensions and solving it by geometry or plane trigonometry.

The leading astronomer of 9th-century Baghdad, Ḥabash al-Ḥāsib, achieved an exact solution of the *qibla* problem by the brilliant analemma construction, that is, by reducing the three-dimensional problem to two dimensions and then solving by a plane geometrical construction – see **Pl. T10**.[670] The celebrated early-11th-century scholar Ibn al-Haytham (965 - *ca*. 1040), who was born in Basra but later worked in Cairo, authored two brilliant studies of the determination of the *qibla* by means of spherical trigonometry and projection methods, respectively. The former, written first, is remarkable for the fact that all of the possible cases ($0 < c < 360°$ and $-90° < a < +90°$) are considered. The second, which uses an analemma construction, is spectacular for its conciseness, and from it the modern formula can be derived immediately.[671] Ibn al-Haytham surely wrote on

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670 Kennedy & ‘Id, “A letter of al-Bīrūnī: Ḥabash al-Ḥāsib’s analemma for the *qibla*” (1973).

671 See respectively Schoy, “Abhandlung des ... Ibn al-Haiṯam (Alhazen) über die Bestimmung der Richtung der Qibla” (1921), procedure replicated in King, “al-Khalīlī’s qibla table” (1975), pp. 115-118; and Dallal, “Ibn al-Haytham’s universal solution for finding the direction of the qibla by calculation” (1995).

the direction of the *qibla* at Cairo, but whatever he wrote has not been preserved for us.

The so-called "method of the *zīj*es" for the determination of the *qibla* was developed in the mid-9th century, probably by Ḥabash al-Ḥāsib, who is the first known author to have proposed it explicitly. It was also favoured by the major astronomers for centuries thereafter. The procedure was first derived by spherical trigonometry (anonymous 9th-century author, maybe Ḥabash), then by projection methods (Ḥabash), then by spherical trigonometry (various 10th-century scholars).[672] It involves finding three auxiliary quantities "modified" from c, b, and $(a\text{-}b)$ and defined using:

$$\sin c' = \sin c \cos b \quad ; \quad \sin b' = \sin b / \cos c' \quad ; \quad \text{and} \quad (a\text{-}b)' = a - b' .$$

With these auxiliary quantities d and q are determined by:

$$\cos d = \cos c' \cos (a\text{-}b)' \qquad \text{and} \qquad \sin q = \sin c' / \sin d .$$

What is involved here is essentially a conversion of equatorial/polar coordinates (longitude and latitude) to coordinates centred on a specific point on the sphere (*qibla* and distance).

al-Bīrūnī's *magnum opus* on mathematical geography

The most comprehensive medieval discussion of mathematical *qibla*-procedures is by the celebrated al-Bīrūnī, who worked in Central Asia *ca.* 1025. In his treatise كتاب تحديد نهايات الاماكن, *Taḥdīd nihāyāt al-amākin*, "The Determination of the locations of cities", the leading scientist of medieval Islam set out to establish the geographical coordinates of Ghazna (now in Afghanistan) in order to compute the *qibla* there: the result was an involved discussion of determinations of terrestrial latitude, the length of

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672 Berggren, "A comparison of four analemmas for determining the azimuth of the *qibla*" (1980), and "The Origins of al-Bīrūnī's 'Method of the *Zīj*es' in the theory of sundials" (1985), also King, "Early Islamic methods and tables" (1987/88), pp. 115-129. See also the summary in Berggren, *Episodes in the Mathematics of medieval Islam* (1986), pp. 182-186.

a degree along the terrestrial meridian, the differences in terrestrial longitudes by eclipse observations, the distances between cities by measuring caravan routes, and the derivations of the *qibla* for a given locality by mathematics, *inter alia*.[673] Having first determined the longitude difference between Mecca and Ghazna with remarkable accuracy, al-Bīrūnī then applied complicated techniques of spherical trigonometry and projection methods to derive the *qibla*. His treatise is the most valuable work on mathematical geography from the medieval period.

Tables displaying the *qibla* for all longitudes and latitudes

> "It has not been previously noted that certain Muslim scholars compiled tables for finding the *qibla*, and the purpose of this paper is to describe such a table prepared by the 14th-century Syrian astronomer al-Khalīlī, which is the most sophisticated trigonometric table known to me from the entire medieval period." DAK, "al-Khalīlī's *qibla* table" (1975), pp. 81-82. (Replace "the entire medieval period" by "between Antiquity and the early modern period".)

Muslim astronomers compiled a series of tables displaying the *qibla q* for each degree (within a certain range) of longitude difference from Mecca *c* and latitude difference (*a-b*) or latitude *a* based on both approximate and exact formulae. The first of these was prepared in Baghdad, probably in the 9th century, and displays values of the *qibla* in degrees and minutes for each 1° of *c* and (*a-b*) from 1° to 20°.[674]

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673 al-Bīrūnī, *Taḥdīd nihāyāt al-amākin*, text, P. Bulgakov, ed., 1962; transl. Jamil Ali, *The determination of the coordinates of cities: al-Bīrūnī's* Taḥdīd nihāyāt al-amākin, 1966; and E. S. Kennedy, *A commentary upon al-Bīrūnī's* Taḥdīd nihāyāt al-amākin, 1973.

674 King, "Earliest Islamic methods and tables for finding the direction of Mecca" (1987/88), pp. 108-115.

Also Ibn al-Haytham, the late contemporary of Ibn Yūnus, mentions in his autobiography that he wrote a treatise "on the determination of the azimuth of the *qibla* in all of the inhabited world by tables which I compiled ... "; unfortunately, this treatise has not been preserved for us.[675]

Several other *qibla*-tables are known but the most impressive from the point of view of its scope and its accuracy is that of the 14th-century Damascus astronomer Shams al-Dīn al-Khalīlī, which displays $q(c,a)$ to degrees and minutes for each 1° of c from 1° to 60° and each 1° of a from 10° to 50°, with most of the 2,880 entries accurately computed – **Pl. T11**.[676] How much such a table was used is another matter: all three copies are from Damascus, and not a single reference to the table is known from any other astronomical work.

Geographical tables with *qibla*s for numerous localities

The extensive geographical tables that were a standard feature of Islamic *zīj*es rarely included *qibla*-values.[677] The earliest known table of this kind was by ʿAbd al-Raḥmān al-Khāzinī, who worked in Merw in Central Asia (modern Mary in Turkestan) *ca*. 1125. It gives the *qibla*-values of about

[675] *Ibid*., pp. 133-134.

[676] King, "al-Khalīlī's *qibla* table" (1975), and *In Synchrony with the Heavens,* vol. 1 (2004), for a discussion of this (pp. 386-390) and al-Khalīlī's other tables which constituted the imposing "Damascus corpus" (pp. 359-401). See also Van Brummelen, "The numerical structure of al-Khalīlī's tables" (1991), for an investigation of the universal auxiliary tables and *qibla* table of al-Khalīlī, who purpose was to ascertain how they might have been computed. For the *qibla* table it proved impossible to determine how the values could have been computed so accurately.

[677] On these see Kennedy & Kennedy, *Geographical coordinates from Islamic sources* (1979), which contains longitudes and latitudes from some 80 medieval astronomical and geographical works. The computer output containing 14,000 pairs of coordinates is arranged according to locality, source, increasing longitude and increasing latitude.

250 localities along with their longitudes and latitudes. These basic coordinates appear to have been read from a map, for they are mainly those of his predecessor by one century, al-Bīrūnī, as found in his astronomical handbook, but generally rounded to the nearest 0;10°, and occasionally there is a jump of 1° or 2° in one or other of the coordinates. al-Khāzinī's *qibla*-values are likewise given to the nearest 0;10° but invariably they do not correspond to the longitudes and latitudes as well as one might expect; indeed, the errors can be as much as several degrees in places.[678]

Another table of this kind is found in a work by the Cairene astronomer Najm al-Dīn al-Miṣrī *ca*. 1325, whom we have already encountered. This gives the longitudes, latitudes and *qibla*s (measured from the east or west) of some 150 localities, and whilst entries for both coordinates are given to the nearest degree, the *qibla*-values are computed to the nearest minute but do not correspond happily to the coordinates.[679] Several other Egyptian tables of this kind present similar problems.

A more successful table was that associated with al-Khalīlī (see above), serving 48 localities mostly in Syria and Palestine: here the *qibla*-values are remarkably accurate.[680] An Ottoman list of *qibla*-values for cities in the Ottoman Empire is available and could be useful for investigating the orientations of Ottoman mosques.[681]

An enormous table very different from any of the others in its scope was compiled in 15th-century Timurid Central Asia. The author has not been

678 King, *World-Maps for finding the direction and distance to Mecca* (1999), pp. 71-75 & 564-585, also "A world-map in the tradition of al-Bīrūnī and al-Khāzinī ... " (2007) in n. 686 below.

679 King, *World-Maps* (1999), pp. 78-80 & 603-606.

680 King, *World-maps* (1999), pp. 390-393, and *Synchrony*, vol. 1 (2004), pp. 390-393, also "A geographical table from 14th-century Damascus with *qibla*-values for localities in Mamluk domains (Syria & Palestine)" (2019).

681 King, *World-Maps* (1999), pp. 86-87 & 622, also "An Ottoman list of qibla-values for localities in the Ottoman Empire" (2018).

identified, but he seems to have had a connection with the astronomical activity in Samarqand *ca*. 1425. In the available version of this table, values of the *qibla* and the distance to Mecca are given to the nearest minute, virtually without error, for 274 localities. But the original table had values of *q* and *d* in degrees, minutes and seconds, and even the seconds were accurate to within a few digits.[682] The information in this remarkable table, in its simplified form, was used in the gazetteers which were common on Iranian astrolabes and compasses from the 17th century onwards.

Instruments for finding the *qibla*

Several types of instruments were devised over the centuries for finding the *qibla*. One variety serves to actually determine the *qibla* of any locality: isolated examples of spherical devices for finding the *qibla* graphically are attested from the 12th century to the 14th.[683] Another variety has markings based on computed *qibla*-values that provide a convenient practical means of displaying the *qibla*. From the 12th century onwards we sometimes find *qibla* directions for a specific locality marked on the backs of astrolabes or on horizontal sundials. Iranian instrument-makers from the 16th century onwards were fond of representing graphically on the backs of astrolabes, for various localities, the solar altitude in the direction of the local *qibla* for all solar longitudes (that is, throughout the year).[684]

Qibla-indicators in the form of magnetic compasses with information on the *qiblas* of various localities engraved around their rims are described in texts from the Yemen and from Egypt *ca*. 1300. A glazed ceramic bowl from Damascus *ca*. 1520 with *qibla*-values painted on it seems to attest to

682 King, *World-Maps*, pp. 86, 149-161 & 456-477.

683 Lorch, "al-Khāzinī's 'sphere' that rotates by itself" (1980).

684 King, *World-Maps* (1999), pp. 186-191.

an earlier Iranian tradition.[685] Brass *qibla*-indicators were particularly popular in Iran from the 17th century onwards, engraved with *qibla*-values from the Timurid geographical table in various degrees of corruption.

World-maps for finding the *qibla*

Muslim scholars also prepared maps specifically for finding the *qibla*. One from treatise on folk astronomy from early-13th-century Egypt is naïve: on a standard coordinate grid fitted within a circular frame one simply joins one's locality to the position of Mecca and measures the inclination of the line segment to one's local meridian – see **Pl. T12**. In spite of its simplicity, this approximate procedure could work reasonably for localities in such regions as Egypt and Iran. However, the map is not Mecca-centred and directions around the circumference are crudely (and incorrectly) associated with solar risings and settings. The map thus constitutes a unique example of the combination of mathematical cartography and folk astronomy. (Closer inspection reveals that the basic map was compiled using coordinates from al-Khāzinī ultimately derived from al-Bīrūnī.[686])

A 'qibla-map' 'invented' by an Armenian for the Ottoman Grand Vizier in the late 1730s, is simply a European map of the landmass north of the equator between West Africa and Japan fitted with a magnetic compass and an additional pointer at Mecca, which, unhappily, is not at the centre.

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685 Article "Ṭāsa (= magnetic compass)" in *Enc. of Islam*, 2nd edn.; Schmidl, "Two early Arabic sources on the magnetic compass" (1997-98); King, *World-Maps* (1999), pp. 107-124, and *In Synchrony with the Heaven*s, vol. 2 (2005), X: 94-101 (general), and XIVb: 715-720. On this bowl the place-names are confused and the numbers garbled, so that is practically useless, but it is still aesthetically pleasing. It was dedicated to the Ottoman Sultan Selim in Damascus *ca*. 1518, who probably never tried to use it to find any *qibla*s.

686 King, "A world-map in the tradition of al-Bīrūnī (1040) and al-Khāzinī (1120) presented by Sirāj al-Dīn al-Sajāwandī (1210)" (2007). See also n. 678 above.

A later Ottoman world-map actually centred on Mecca is also known but has not been studied.[687]

During the period 1989-2001 three remarkable world-maps from Safavid (17th-century) Isfahan came to light. Each is engraved on a circular brass plate some 22.5 cm in diameter and each is fitted with a highly sophisticated longitude and latitude grid centred on Mecca: see **Pl. T13**. Some 150 localities are carefully marked on each map, the coordinates having being taken from the Timurid table mentioned above. A non-uniform linear scale attached at the centre and a scale around the circumference enables the user to read off at a glance the direction of Mecca and the distance to Mecca. A grid achieving this purpose was previously unknown to the history of cartography, Islamic or European, before the early 20th century. But there is no evidence that the Safavid instrument-makers, skilled as they may have been at making celestial globes and astrolabes, would have been capable of designing such mathematically-sophisticated world-map grids. Indeed, the underlying theory of a projection preserving direction and distance to the centre has been found by my colleague Jan Hogendijk in treatises on conic sections from 10th-century Baghdad and 11th-century Isfahan.[688] This tradition represents the culmination of Islamic mathematical cartography, but there is no evidence that it was known outside Iran.

The consequences for the orientation of Islamic religious architecture

The orientations of medieval Islamic religious architecture begin to make sense to the modern mind when one knows how Muslims confronted the

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687 King, *World-Maps* (1999), pp. 97 & 101.

688 King, *World-Maps* (1999), pp. 197-364, on two examples; also *Synchrony*, vol. 1 (2004), VIIc: 825-846, for a third example; and Hogendijk, “Het mysterie van de Mekkawijzers van Isfahan” (2002), and “Three instruments for finding the direction and distance to Mecca: European cartography or Islamic astronomy?”.

qibla problem in centuries past. It is not correct to say that they didn't know what they were doing; it is correct to say that we, until recently, did not know how they did it. Thanks to medieval astronomical and legal texts, we now have a reasonable idea.[689] From one end of the Muslim world to the other, the *qibla* was determined by various procedures:

1. using the foundations of earlier pre-Islamic cardinally- or solstitially-aligned edifices or city-plans (Jerusalem, Damascus, Córdoba, Tunis, and more) because these were considered appropriate for facing associated segments of the perimeter of the Kaʿba (Damascus toward Syrian Corner, Córdoba toward NW Wall, *etc*.);
2. using tradition, so that, for example, certain mosques from al-Andalus to Central Asia face south because the Prophet prayed south when he was in Medina and other mosques will face directions laid out by the Companions of the Prophet;
3. using the methods of folk astronomy, that is, astronomical risings and settings, to face the corners and/or sides of the Kaʿba, itself astronomically aligned, so that, for example, early mosques in Egypt were oriented toward winter sunrise[690] and the earliest mosques in al-ʿIrāq face winter sunset, respectively;
4. using mathematical procedures, either approximate or exact, with medieval (pre-modern) geographical data (the results will, of course, be different from the modern *qibla*s);

689 King, "Astronomical alignments in medieval Islamic religious architecture" (1982); "The orientation of medieval Islamic religious architecture and cities" (1995); "The determination of the sacred direction in Islam" (1995); and "The sacred geography of Islam" (2005); and "Finding the *qibla* by the sun and stars" (2019). Again I draw attention to my "Bibliography on historical *qibla* determinations" (2018), which includes some 150 books and articles.

690 With reservations – see the next Chapter.

5. using *qibla*-values taken from extensive lists of geographical coordinates featuring longitudes, latitudes and *qibla*s (all available ones have been published; and
6. using simple procedures for architects and builders to use in order to lay out the *qibla*, such as three paces south then seven paces west, and the like (simple as they may seem they are intended to reproduce a mathematically-derived *qibla* within a degree or so).[691]

The result of these diverse procedures was that medieval mosques do not face Mecca as we moderns might expect them to. Rather, they face the directions which the builders thought was the *qibla*. Whether the *qibla* was found by folk procedures or mathematical methods or simple architects' procedures (the most likely), these mosques can be said to face the Kaʿba.

Faced with the apparent confusion of mosque orientations from one end of the Muslim world to the other, we are fortunate to have several medieval Arabic texts in which the reasons for such choices in such localities as Córdoba, Fez, Cairo, Isfahan and Samarqand are documented (**Pl. T14**).[692] As in all societies, and especially in matters of religious

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[691] For example, the great al-Bīrūnī (*ca*. 1025) proposes six such simple but adequate practical procedures in his monumental work on the *qibla*, after having calculated the *qibla* at Ghazna (in present-day Afghanistan) by the most detailed scientific procedures as 70°46′56′′ west of south. See Jamil Ali, *The Determination of the Coordinates of Cities .... by al-Bīrūnī* (1967), pp. 255-256, and E. S. Kennedy's *Commentary upon al-Bīrūnī's* Taḥdīd (1973), pp. 214-215. The architects' rules are discussed again in King, "The Ottoman Mosques Fallacy" (2019), pp. 11-12.

[692] For Córdoba see Rius, *La Alquibla en al-Andalus y al-Magrib al-Aqsà* (2000), and King, "The enigmatic orientation of the Grand Mosque in Córdoba" (2019).

For Fez, see Dallal, *Islam, science, and the challenge of history* (2010), pp. 1-9.

On the "al-Karakī affair", involving the orientation of mosques in Iran and al-ʿIrāq, see King, *World-Maps* (1999), pp. 134-138.

practice, there were those who thought that the way they themselves did things was the only correct way.

We shall show how Cairo is a city oriented with respect to the Kaʿba. It is, of course, just one such Muslim city that faces the Kaʿba. What we show is obvious, but few have ever said or written it in modern times.

For Samarqand see King, "al-Bazdawī on the *qibla* in medieval Transoxania" (1983/86).

(Excursus: Remarks on Jewish, Christian and Muslim orientations)

For those who find it difficult to imagine that early Muslims faced astronomical directions for determining the *qibla*, imagine Christians and Jews in medieval Europe wanting to face Jerusalem. As far as I know, we have no evidence that they ever calculated the direction of Jerusalem. They had defective geographical tables at their disposal, but no mathematical means of finding direction of a distant locality. So they were not in a position to calculate the direction of Jerusalem. To face east was a compromise that was not unreasonable. That is why (we think that) medieval European churches and synagogues often face due east. [Now we leave historical reality for a moment and say that facing east in Europe is facing "parallel" to the direction one is facing when standing in front of the western wall of the cardinally-aligned Temple complex. This is not what they did, but if we understand it, we can begin to understand the more complicated methods used in the Muslim tradition of sacred geography.] For both Christians and Jews in the medieval milieu, problems begin when one gets close to Jerusalem, and they get serious when one is in a different "quadrant" of the earth, let alone on the other side of it. This is not the place to discuss orientations in the three traditions, especially when we have no corpus of dated edifices with their orientations.

I therefore cite the brilliant study "The Sacred Direction in Synagogue and Church" by the prolific Jewish art historian Franz Landsberger (1883-1964), published in 1957, and still well worth reading in its entirety.[693] We savour the beginning and end of this little-cited work:

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[693] Franz Landsberger, "The Sacred Direction in Synagogue and Church" (1957), esp. pp. 181 & 203.

See also Joseph Gutmann, "Franz Landsberger, 1883–1964", in *Studies in Bibliography and Booklore* 8: 1 (Spring, 1966): 3-9. Landsberger had found the field of Jewish art "a desert ... broken only here and there by oases", and he paved the way

Opening words: " "Sacred direction" is a term better suited to our present in quiry than "orientation". Etymologically "orientation" signifies a turning toward the east, while we are now concerned not only with the east but also with the west, the north, and the south. It is striking that the position taken in prayer and in the layout of sacred structures has not been left to chance but has been determined by the prevailing religious outlook. This has repeatedly excited study."

Closing words: "Instead of the Jew's believing in a relative direction for prayer which might vary from place to place, there was instilled the belief in an absolute direction, and that absolute direction, namely the east, was the same as it was for Christianity."

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Then we cite the leading expert on medival European astronomy ouside the mathematical tradition, that is, essentially folk astronomy, and especially as it was practiced in monasteries. The American medievalist and astronomy historian Stephen C. McCluskey, authored the article "Orientation of Christian Churches", in the monumental *Handbook of Archaeoastronomy and Ethnoastronomy* edited by Clive Ruggles in 2015:[694]

Abstract: "The orientation of Christian churches reflects the historically documented concepts that one should turn eastward to pray and the architectural and liturgical principle that temples and churches should be constructed facing east (often specified as equinoctial east). Since many churches do not face equinoctial east, various attempts have been made to explain this deviation. Among them are the idea that those churches were incorrectly built or that they were oriented toward sunrise on the date their

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for it to become a legitimate branch of Jewish intellectual heritage (*Wissenschaft des Judentums*).

694 Stephen C. McCluskey, "Orientation of Christian Churches", in Clive Ruggles, *A Handbook of Archaeoastronomy and Ethnoastronomy* (2015), pp. 1703-1710, esp. p. 1703.

foundation was laid or on the feast or the saint to whom the church was dedicated."

The article "Orientation" in *The Oxford Dictionary of the Christian Church* (1997) is singularly ill informed about orientations of churches, believing that all face east. At least it is conceded that:

"Though orientation is derived historically from a pagan habit of praying towards the sunrise, Christians have seen in its adoption symbolic reference to Christ as the Rising Sun."

The Italian physicist and archaeoastronomer Amelia Carolina Sparavigna has documented a range of 40° to 145° for major medieval French cathedrals.[695] In other words, they do not face east (90°), with some of them facing even beyond the ranges of sunrise along the eastern horizon.

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Finally, some remarks on the situation in the Islamic world from my articles "Qibla (sacred direction)" and "Mecca as centre of the world" in the 2nd edn. of the *Encyclopaedia of Islam*:

"This purely Islamic development of a sacred geography featuring the world centred on the Kaʿba provided a simple practical means for Muslims to face the Kaʿba in prayer. For the pious, to whom the "science of the ancients" was anathema, this tradition constituted an acceptable alternative to the mathematical *qibla* determinations of the astronomers. ... . The number and variety of the texts in which this sacred geography is attested indicate that it was widely known from the 10th century onwards, if not among the scientific community. The broad spectra of *qibla* values accepted at different times in different places attest to the multiplicity of ways used by Muslims to face the Kaʿba over the centuries, and all of this activity was inspired by the belief that the Kaʿba, as the

[695] Amelia Carolina Sparavigna, "Exercises in Archaeoastronomy" (2018), esp. pp. 23-27.

centre of the world and the focus of Muslim worship, was a physical pointer to the presence of God."

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Thus we can generalize and say that the orientation of synagogues, churches and mosques is not always what people think it is and what the 'authorities' say it is.

15 — The *qiblas* used in medieval Fustat-Cairo

Extract from the seven-sector scheme of the world about the Kaʿba by Ibn al-Qāṣṣ (MS Cairo Taymūr *buldān* 103 = Ibn al-Qāṣṣ, pp. 9-10):

“A statement on the direction (*jiha*) of localities with respect to (*ilà*) the Kaʿba. God – sublime is the mention of His name – said: “Wherever you are turn your faces towards (the Kaʿba).” Thus it is the duty of the inhabitants of every region to direct their prayer towards the Kaʿba in the appropriate direction (*ʿalā qadr mā yalīhim min jihātihi*). ... ... The *qibla* of the inhabitants of Cairo and Alexandria, Tangiers, [Rome (رومة, text has رقة, Raqqa)], the Franks (*Frnjh*), al-Andalus and Kairouan is from the western corner to the middle of the back side of the Kaʿba (that is, the south-western wall).”

Extract from the eight-sector scheme recorded by Ibn al-Ajdābī (*Kitāb al-Anwāʾ*, pp. 120-125):

“The sectors of the Earth surround Mecca – may God Almighty honour it – in each of these directions (of the four winds which have just been described). There are those which are East of Mecca and those which are West of it, and those which are to the North and South of it. There are eight sectors: three of them are western, three eastern, one to the north and another to the south ... . In the Western Sector to the north of the parallel of Mecca – may God honour it – the direction of the *qibla* is towards winter sunrise and what is close to that, which is (the direction) facing the wall of the Kaʿba – may God Almighty protect it – in which is the Waterspout. The *qibla* in this sector is found by having the Pole Star over the left shoulder, and Antares rising in front of the face. By day, the sun when it culminates on the meridian should be at the edge of the right eyebrow. The localities in this sector are Medina, the City of the Prophet – may God bless and praise Him – and Jerusalem – may God protect both (cities) –, as well as Cairo, Alexandria, Tripoli,

Ifriqiya, Andalusia and Sicily."

Extract from the treatise of on the sine quadrant by Ibn al-Qāṣiḥ (MS Vatican ar. 317,4, fols. 110v-111v):

"Chapter 64 on which sections (*jihāt*) of the Kaʿba people in different countries should face. ... ... You should know that the inhabitants of Cairo-Fustat, Alexandria, Kairouan, and over as far as Tahert, al-Sūs al-Aqṣā and the Atlantic Ocean, and places in the same direction, pray toward the section of the Kaʿba from the Western Corner to the Waterspout. ... ... "

"The most significant characteristic of the mosque is the direction that it faces." H. Masud Taj, "Facing the city" (1999) (my emphasis).

There were several directions accepted for the *qibla* in medieval Cairo-Fustat. The most popular directions were the so-called *qibla* of the *ṣaḥāba*, that is, the *qibla* of the Companions of the Prophet, facing winter sunrise at 27° S of E., and the *qibla* of the astronomers, starting in the late 10th century (as far as we know), facing 37° S of E. But there were others, and these are only mentioned in texts. There are, for example, the texts on sacred geography excepted above, which propose different directions altogether. It remains to investigate whether and how these may have been adopted in practice.

The Mosque of ʿAmr in Fustat

"**To avoid confusion**, I have adopted throughout the terms of orientation as given by Al-Makrizy. He treats the Kibla side of the Mosque (i.e. that supposed to be directed towards Mekka) as south; and names the other sides accordingly. As a matter of fact, the axis of the mihrab points as near as possible S.E. by E.: and therefore it would of course be nearer to the facts to call it E.; but **the confusion it would introduce in following our authority through the history would be considerable, while real accuracy would not be obtained**. The plans are therefore all marked according to Al-Makrizy's system, and all references to the points of the compass

> are to be understood in this sense. The correct orientation is also indicated outside Plan I." Eustace Corbett, "The history of the mosque of Amr at Cairo" (1890), p. 759, n. 1 (my emphasis).

The Mosque of ʿAmr is the first mosque to have been built in Egypt. Histories of the Mosque have been written at least twice,[696] neither focussing on the orientation. This is a prickly subject, for it seems that the orientation was changed at least twice over 1400 years. I shall do no more than present a few historical texts that cast some light on the matter, but also considerable confusion. Eustace Corbett, who published a detailed monograph on the Mosque in 1890, presented three plans showing the Mosque at due east in 642, *ca*. 30° S of E (winter sunrise) in 827, and *ca*. 25° S of E (winter sunrise) in his time.[697]

Both of the two principal *qibla*s – winter sunrise and the astronomically-computed direction – are mentioned for the Mosque by a 16th-century Cairo astronomer Ghars al-Dīn al-Ḥalabī.[698] He is the first astronomer known to have commented on the situation, but unlike some of the other authors we shall cite, he actually knew what the problem was and what the different *qibla*s signified. Yet even al-Ḥalabī as an astronomer describes the situation some 900 years before his time in the following rather simplistic and pietistic terms:

المقصد الثاني اعلم انه في سنة ثمانية عشر من الهجرة في زمن خلافة عمر بن الخطاب رضي الله عنه فتح عمرو بن العاص مصر ثم بنى مسجده المشهور بالجامع الجديد وكانت اصحاب

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696 Eustace Corbett, "The history of the mosque of Amr at Cairo" (1890), and Tarek Swelim, "Mosque of 'Amr ibn al-ʿĀṣ" (2013), written within the context of the history of Fustat.

697 Corbett, *op. cit.* (1890), plans I-III.

698 On al-Ḥalabī see Suter, *Mathematiker und Astronomen und ihre Werke* (1900), no. 465; *Cairo Survey*, no. C88; and Rosenfeld & İhsanoğlu, *Mathematicians, Astronomers and other scholars of Islamic Civilisation* (2003), no. 983. His treatise exists in several copies, of which I have used MS Cairo ENL Muṣṭafà Fāḍil *mīqāt* 114, copied *ca*. 1600, where this passage occurs on fols. 5r-5v.

رسول الله صلى الله عليه وسلم يوميذ في مصر حال بناه نيفا وثلثين وكان معهم من المسلمين المجاهدين نحو ستة عشر الفا وقد كان سمت المحراب للمسجد المذكور نحو سبعة وعشرين درجة ولم ينكر احد من المذكورين على ذلك بل كان باجماعهم واهل الحساب لما اخرجوا سمته بالطرق الحسابية المبرهنة حكموا بان السمت بمصر سبعة وثلاثون وحكموا بتخطية المحراب المذكور وفي ذلك خطر عظيم اذ في ذلك تخطية الصحابة الذين قال صلى الله عليه وسلم في حقهم اصحابي كالنجوم بايهم اقتديتم اهتديتم ولهذه القصة نظاير كثيرة من مشاهد الصحابة وقبورهم ومساجدهم وايضا ذهب القايلون باصابة العين الى ان الكوفة وبغداد وهمذان وقزوين والري سمتهم واحد والحال ان بينهم تفاوت نحو اربع درج ومن هذا او امثاله وقع كثير من الناس في الحيرة والخبط ومما قدمناه نرجو من فضل الله ان ينحل هذا الاشكال ...

“Know that in the year eighteen of the Hijra (639 C.E.), in the time of the Caliphate of ʿUmar ibn al-Khaṭṭāb – may God be pleased with him – ʿAmr bin al-ʿĀṣ conquered Fustat (*Miṣr*), and then he built his mosque (which was then) known as the New Mosque. The Companions of the Prophet – may God bless him and grant him salvation – who were in Egypt when he built (the mosque) were more than thirty (in number), and there were about sixteen thousand Muslim fighters of the holy war with them. The azimuth of the *miḥrāb* of this mosque was about 27° (S of E), and no one amongst those mentioned contested this, rather (the *miḥrāb* was placed in this direction) with their unanimous agreement. The astronomers, when they determined the azimuth (of the *qibla*) by proven mathematical means, decided that the azimuth in Fustat is 37° (S of E). They (further) decided that the *miḥrāb* (which we) mentioned was wrong. Now there is great danger in this, since it (amounts to) saying that the Companions have erred. (The Prophet) – may God bless him and grant him salvation – said of them: “My companions are like stars; whichever of them you follow, you will be (rightly) guided. This story has many parallels in respect to the shrines and graves and mosques of the Companions. Those who hold the opinion that one should face directly towards the Kaʿba (*iṣābat al-ʿayn*) think that Kufa, Baghdad, Hamadhan, Qazwin, and Rayy have one and the same azimuth. The (real) situation is that there is a difference of about 4° [*sic*, read 14°!] between them. As a result of this and similar (problems), many people have become confused and mixed up. As a result of what we have presented (in this treatise), we hope by the grace of God that this obscure problem may be solved.”

We have discussed in **Ch. 14** the notion of *iṣābat al-ʿayn* referred to by al-Ḥalabī, as well as the notion from sacred geography of the *qibla* for a swathe of localities from Kufa to Rayy being essentially the same.

The story of the foundation of the mosque of ʿAmr and its orientation is far more complicated than al-Ḥalabī knew. The historical sources have already been investigated by K. A. C. Creswell, who was not in a position to understand the references to the *qibla*.[699] In any case, in Egypt, winter sunrise at 117°, or 27° S of E, was taken as the *qibla* of the Companions of the Prophet, even though it was apparently not the orientation of the first mosque erected in Fustat. This was built by the military commander ʿAmr ibn al-ʿĀṣ in the winter of 641/42. The 15th-century historian al-Maqrīzī relates two stories about the way in which ʿAmr had the *qibla* laid out.[700] The text reads:

> ... وقال داود بن عقبة ان عمرو بن العاص بعث ربيعة بن شرحبيل بن حسنة وعمرو بن علقمة القرشي ثم العدوي يقيمان القبلة وقال لهما قوما اذا زالت الشمس او قال انتصفت الشمس فاجعلاها على حاجبيكما ففعلا وقال الليث ان عمرو بن العاص كان يمتد الحبال حتى اقيمت قبلة المسجد وقال عمرو بن العاص شرقوا القبلة تصيبوا الحرم قال فشرقت جدا فلما كان قرة بن شريك * تيامن بها قليلا وكان عمرو بن العاص اذا صلى في مسجد الجامع يصلي ناحية الشرق الا الشيء اليسير وقال رجل من تجيب رايت عمرو بن العاص دخل كنيسة فصلى فيها ولم ينصرف عن قبلتهم الا قليلا ... (* perhaps there is a lacuna here)

The first story translates:

"ʿAmr sent two men (named in the text) to set up the *qibla* and said to

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[699] Creswell, *Muslim architecture of Egypt* (1952), I, pp. 149-151. See also Butler, *The Arab conquest of Egypt* (1978 edn.), p. 343. On the Mosque see, most recently, Tarek Swelim, "The Islamic heritage of Old Cairo – The lost city of Fustat and the Mosque of 'Amr ibn al-'As", in Gabra *et al*., *The History and Heritage of Old Cairo* (2013).

[700] al-Maqrīzī, *al-Khiṭaṭ*, II, p. 247. The same stories are recorded by the contemporaneous (?) Egyptian writer Murṭaḍà ibn Khafīf, whose treatise is available only in an unreliable French translation prepared in 1666: see Murṭaḍà, pp. 252 ff. of Vattier's translation.

> them: “Stand when the sun is beginning to decline – or, in another version when the sun is on the meridian – and have (the sun) at your two eye-brows,” and they did (this).”

The instructions given here, in terms of the position of the sun in the sky relative to parts of the human body, are typical of early directional indicators. Often we even find sunrise or sunset mentioned without any specification of the time of year. The men here were clearly told to be facing due east, in indirect terms, namely, by facing perpendicular to the direction of the sun when it was highest in the sky, that is, on the meridian.

The second story records:

> “ʿAmr was laying out ropes so that the *qibla* of the mosque could be set up, and he said: “Make the *qibla* toward the east (*sharriqū ‘l-qibla*) and you will face the Kaʿba.” ... (The *qibla*) was too far to the east.”

Of course, شرقوا القبلة, *sharriqū/u ‘1-qibla*, can also mean “make the *qibla* towards sunrise”. al-Maqrīzī relates that when ʿAmr prayed in the mosque, he prayed almost toward the east (ناحية الشرق الا الشيء اليسير, *nāḥiyat al-sharq illā ‘l-shay’ al-yasīr*), and that when he prayed in a church he would pray almost in the *qibla* of the Christians, *i.e.*, due east (لم ينصرف عن قبلتهم الا قليلا, *lam yanṣarif ʿan qiblatihim illā qalīl*[an]). Ibn Taghrībirdī and also al-Qalqashandī, but not al-Maqrīzī (although the published text seems to be defective), report that when the Mosque was enlarged by Qurra ibn Sharīk, the Governor of Egypt for the Umayyad Caliph al-Walīd ibn ʿAbd al-Malik in Damascus from 709-14, it was actually pulled down and rebuilt on a larger scale in a different direction, more to the south, an undertaking completed in 712.[701] Ibn Taghrībirdī’s remarks are as follows:

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[701] Ibn Taghrībirdī, *al-Nujūm al-ẓāhira*, I, p. 67, II, 1-6, and al-Qalqashandī. The earlier historian Ibn ʿAbd al-Ḥakam states that Qurra pulled the mosque down (*hadama*) but does not mention its orientation either before this event or after the

... وكانت القبلة مشرقة جدا وان قرة بن شريك لما هدم المسجد المذكور وبناه في زمان الوليد بن عبد الملك بن مروان تيامن بها قليلا ...

“The *qibla* was much too far to the east. When Qurra ibn Sharīk pulled down his mosque and (re)built it in the time of al-Walīd he turned (the *qibla*) a little to the south.”

Now al-Maqrīzī seems to be saying again that the mosque of ʿAmr was built facing east. Ibn Taghrībirdī and al-Qalqashandī (and probably al-Maqrīzī too, if indeed the published text is defective) seem to be saying that Qurra ibn Sharīk rebuilt the mosque in a more southerly direction, but they do not mention that this new direction was toward winter sunrise. A change of *qibla* from due east to the direction of winter sunrise (some 27° clockwise) should hardly be described as a change “a little to the south”. It is not my intention to dwell on the possibility that there were no *ṣaḥāba* left when the Mosque was reoriented in what was in later centuries called “the *qibla* of the *ṣaḥāba*”.

The history of the Mosque is complex and no attempt will be made here to survey it. However, for example, in 1303 it was destroyed in an earthquake and rebuilt, and as late as 1401, the *qibla* wall of the Mosque was demolished and rebuilt, presumably in a slightly different direction. In 1796 it was pulled down and rebuilt by the Mamluk Murād Beg. The present Mosque is not rectangular in shape, which adds to the difficulty of identifying the precise *qibla* used in its orientation. From Google Maps I

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reconstruction: see Ibn ʿAbd al-Ḥakam, p. 131, l. 16. See also the article “Ḳurra ibn Sharīk” in *Enc. Islam*, 2nd edn., by C. E. Bosworth.

With so many *qibla*s floating about it is easy to become confused, as happened already in medieval Cairo. The American archaeologist Donald Whitcomb (“Umayyad legacy for Fusṭāṭ” (2010), p. 407) states that the Mosque was reconstructed in 710-712 perhaps because it was felt necessary to change the orientation from the “*qibla* of the *ṣaḥāba*” (117°) to the “*qibla* of the astronomers” (127°). It seems, though, that the orientation was changed from due east (90°) to what was later called the “*qibla* of the *ṣaḥāba*” (117°). The astronomers came later.

measure the orientation of the outer *qibla*-wall to be at about 50° S of E, which may represent an attempt to align it in the (early) modern *qibla* for Cairo, the modern *qibla* being 46° S of E. If it were an astronomical alignment one would need to investigate the altitude of the hills to the south-east. Any investigations of the Mosque as it is today cannot be expect to yield any serious historical information.

Various things are clear: The first *qibla* of the Mosque was toward the east, and the second one was apparently toward winter sunrise, which direction was referred to in later centuries as *qiblat al-ṣaḥāba*. The Mosque is no longer aligned in what used to be called "the *qibla* of the Companions".

What we do not know is why they chose these *qibla* directions. The earliest Muslims who erected the Mosque of ʿAmr facing east perhaps wanted it to be facing the Western Corner of the Kaʿba. The next group, who rebuilt the Mosque 70 years later toward winter sunrise, may have wanted it to be facing the north-west wall of the Kaʿba, and to do this, they thought it should be facing winter sunrise. Some later Egyptians thought it more reasonable to face the rising point of Canopus, the brightest star in the southern hemisphere and a south indicator (as far north as about 36°), as the stars of the Plough constitute a north indicator. When one stands in front of the north-west wall of the Kaʿba in Mecca one is facing the rising point of Canopus, and al-Maqrīzī – see below – informs us that this latter direction was also adopted for the *qibla* in Egypt (slightly different from the direction in Mecca because of the difference in latitude). Indeed, al-Maqrīzī himself actually confuses the midwinter sunrise and the rising point of Canopus.

A *qibla* toward the east?

In a publication of mine from 1982, I suggested that the *qibla* of the polytheist Arabs of the Hejaz in the time before the introduction of the *qibla* towards Jerusalem, which occurred some time before the advent of Islam, was towards the east. One indication of this is that when one is standing in front of the south-west wall of the Kaʿba, one is facing (استقبل, *istaqbala*) the favourable easterly wind called the قبول, *qabūl*, and one is

standing in the قبلة, *qibla*.[702] Previously, the Russian orientalist of German descent Wilhelm Barthold (1869-1930) had argued that the *qibla* of the earliest mosques of the Hejaz (Medina and Qubā') was originally towards the east.[703] The Swedish scholar of comparative religion Tor Andrae (1885-1947) also believed that the first *qibla* was toward the east.[704] The topic was further investigated in a ground-breaking and well-documented article by the Druze Arab scholar Suliman Bashear (1947-1991), entitled "Qibla *musharriqa* and early Muslim prayer in churches" (1991).[705] Bashear of course discussed the first *qibla* of the Mosque of ʿAmr, which was مشرقة جدا, *musharraqa jidd*[an], "much too far to the east", and had to be rebuilt facing a different direction (winter sunrise at 27° S of E).

In any case, it does seem that the earliest *qibla* used for mosque orientation in Egypt was due east. We note that the direction of due west was used for the *qibla* in early Islamic al-ʿIrāq, Iran, and Central Asia, but the direction of winter sunset was also favoured in those regions.[706]

Revisionists get very excited when they learn of a *qibla* or a mosque orientation toward the east; they immediately suspect the possible influence of Christian practice. (They also probably still think that early synagogues and churches were oriented towards Jerusalem – without any mathematical intervention! I know of no serious discussion of this in the medieval period! – or, as a simple expedient, facing east. Archaeo-astronomy has dispelled both of these myths.) Some effort has been

702 King, "Astronomical alignments in medieval Islamic religious architecture" (1982), pp. 308-309.

703 Barthold, "Die Orientierung der ersten Moscheen" (1929).

704 Andrae, *Der Ursprung des Islam und das Christentum* (1926), p. 4., cited in A. J. Wensinck, article "Ḳibla. Ritual and legal aspects", in *Enc. Islam*, 1st edn., also in 2nd edn., V (1979), p. 82, and again by Bashear – see next note.

705 Bashear, "Qibla *musharriqa* and early Muslim prayer in churches" (1991), esp. p. 268.

706 See King, "al-Bazdawī on the qibla in Central Asia" (1983/86), for details.

devoted to interpreting the words *sharraqa* or *yusharriqūna* or *musharraqa* or *tashrīq* in relation to the direction of prayer to the east (الشرق, *al-sharq*) or more toward the east (مشرقة, *musharraqa*), this mainly by people who had no idea that the earliest *qibla*s were determined by cardinal or solstitial directions or what the appropriate contemporaneous *qibla* might or should have been.

As far as I know, no other orientations in Fustat have ever been investigated. All manner of archaeological plans are available.

The new city of Cairo

The Canal joining the Nile to the Red Sea[707] originated in Ancient Egyptian times, and was named for the Pharaoh Sesostris. Restored by the Emperor Trajan, the canal acquired a new entrance which was relocated to the south of the Roman Fortress of Babylon, and thus passed through the Fortress itself. Gradually it fell again into disuse. After the Arab conquest of Egypt in 641 and the establishment of their capital of Fustat to the north of Babylon, it was necessary to re-establish a connection to the Red Sea and the Arabian Peninsula, the homeland of the conquerors. The general ʿAmr Ibn al-ʿĀṣ ordered that the canal be re-opened, with a new mouth to the north of Babylon. The canal was then named Khalīj Amīr al-Mu'minīn after the Caliph at that time ʿUmar ibn al-Khaṭṭāb. In the 8th century this direct connection with the Red Sea was blocked by order of the Abbasid Caliph al-Manṣūr, and the Canal terminated at a depression southeast of the Delta, where it formed a lake called Birkat al-Ḥajj, the first station on the caravan route to Mecca. During the reign of the Fatimid Caliph al-Ḥākim (996-1021), the Khalīj was restored, and renamed al-Khalīj al-Ḥākimī. It was usually referred to as al-Khalīj al-Misrī or simply al-Khalīj.

The roughly rectangular, roughly orthogonal grid of the new Fatimid city of al-Qāhira, the "City Victorious" founded in 969, was laid out alongside

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707 This paragraph is based on Behrens-Abouseif, *Azbakiyya and its Environs* (1985), p. 1.

the Red Sea Canal. It happened that for a substantial part of its length at that location, the Canal was rectilinear, that is, straight. It also happened that at that part of its length, the Canal was perpendicular to winter sunrise. As a result, the minor axis of the city was toward winter sunrise, which was "the *qibla* of the Companions". See **Pls. U2-U4**.

Inevitably we have no medieval discussion of the fortuitous association between the so-called "*qibla* of the Companions" and the layout of the new city of al-Qāhira. Likewise, we find no medieval discussion of the equally fortuitous association of the *qibla* of the astronomers and the layout of the City of the Dead.

In both of these cases, hydrography has played the leading role. The associations are not hypothetical because they can easily be confirmed on a map. They simply had not been noticed in modern times before the discovery of the astronomical alignment of the Cairo wind-catchers. Even two experts on the influence of water on urban form, Stuart P. Echols and Hala F. Nassar, who in 2006 studied the situation in Cairo mainly from the view-point of the 18th and 19th centuries,[708] inevitably without being aware of the connection between the orientation of the Red Sea Canal and the early *qibla*, which, we repeat, is fortuitous but also very nice.

We shall return to the Canal and the Fortress of Babylon, together with Peter Sheehan's new book, in **Ch. 16**.

Ibn Yūnus computes the *qibla* for Cairo

In Chapter 28 of the *Ḥākimī Zīj*, Ibn Yūnus presents three complicated trigonometric procedures for finding the *qibla*, each mathematically equivalent to the other. These formulae were derived by considering the zenith of Mecca as a point on the celestial sphere and projecting the various base circles into a single plane by means of a procedure from

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708 Echols & Nassar, "Canals and lakes of Cairo: influence of traditional water system on the development of urban form" (2006).

Greek mathematics known as the analemma: the problem can then be solved by plane trigonometry.[709]

The three procedures, although mathematically equivalent, will give slightly different results in the seconds (!!) because of rounding of intermediate values during the operation. Ibn Yūnus derived 53°0′6′′ and twice 53°0′7′′ E of S. (The accurate value for his choice of coordinates for Cairo and Mecca is 53°0′2′′!) He then presents a table of the altitude of the sun in degrees and minutes when it is in the azimuth of the *qibla* for each degree of solar longitude, corresponding roughly to each day of the year. This table is based on a *qibla* of 38° S of E, and Ibn Yūnus says he computed it "some time ago". In the Cairo corpus of tables for timekeeping by the sun and regulating the times of prayer, this table occasionally reappears, although more often it is replaced by a table of the same function based on Ibn Yūnus' new *qibla* of 37° S of E. Related tables of the time before midday when the sun has this azimuth are also found in the corpus.[710]

To orient oneself to pray toward the direction of Mecca it is sufficient – as in modern practice – to know the *qibla* to the nearest degree or so. Likewise, for laying out a mosque, simple rules of thumb were used by architects to the satisfaction of all: from a given point on a flat surface step so many paces to the south and so many paces to the west, then the direction of where you arrive viewed from the starting point indicates the *qibla*.[711]

Fatimid mosques erected in the *qibla* of Ibn Yūnus

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709 King, *The astronomical works of Ibn Yūnus* (1972), pp. 256-268.

710 King, "Ibn Yūnus' *Very Useful Tables*" (1973), p. 368, and *Synchrony*, vol. 1 (2004), II: 268-270.

711 See n. 691 above.

No Egyptian treatises on the *qibla* are known from the 8th or 9th or early 10th century. (The situation in Baghdad was quite different: we have treatises on the determination of the *qibla* from each of these periods.[712])

Within a few years of the foundation of the new city of Cairo, the astronomer Ibn Yūnus, calculated the *qibla* for Cairo as 37° S of E. The al-Azhar Mosque and the Mosque of al-Ḥākim were laid out in this new *qibla*, skew by 10° to the Fatimid city-plan. In later Mamluk religious and architecture the outsides of the principal buildings are aligned with the Fatimid street-plan and the insides with the recently-computed *qibla* of Ibn Yūnus – **Pl. U5**. The 10° divergence can be seen in the window-niches of the edifices but this enigmatic feature is not properly explained in any book on Cairene architecture known to me.

Ibn Yūnus is known to have decided on the orientation of another mosque erected in 1005 by al-Ḥākim. This was the Mosque of al-Rashīda, a district between Fustat and Dayr al-Ṭīn.[713] It must have been of considerable importance to the Caliph because it was called *al-jāmiʿ al-Ḥākimī*. In 1008 al-Ḥākim led prayer and preached the sermon there. In 1011 the mosque was torn down, apparently because it was not properly aligned with the *qibla*. The *qibla* was supposedly recalculated, the mosque rebuilt, and in 1014 the Caliph led Friday prayer there again. It is completely incomprehensible – at least to this author – how this mosque could have been erected in the wrong direction. The *qibla* of Ibn Yūnus was available, and that should have been used to orient the mosque in the first place. There was no need to "recalculate" the *qibla* since Ibn Yūnus had done

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712 King, "The earliest Islamic mathematical methods and tables for finding the direction of Mecca" (1986).

713 This was first related by Aydın Sayılı in his excellent book *The Observatory in Islam* (1960), pp. 151 & 154, quoting al-Maqrīzī, *al-Khiṭaṭ*, II, p. 282; Ibn Taghrībirdī, *al-Nujūm al-ẓāhira*, IV, p. 177, n. 4; and Ibn Khallikān, *Wafayāt al-aʿyān*, II, p. 167. See Sanders, *Ritual, politics, and the city in Fatimid Cairo* (1994), pp. 54-55, for more details, including about the realignment, which Sayılı omitted.

that properly years before (and his value had been used for the al-Azhar and al-Ḥākim mosques). I have not checked the Arabic sources.

The architectural jewel which is the al-Aqmar Mosque on *al-Qaṣaba*, the main axis of the Fatimid city, was built *ca*. 1125 by the Fatimid *wazīr* al-Ma'mūn al-Baṭā'iḥī as a neighbourhood mosque. It is acknowledged as "the first building in Cairo with an adjustment to the street alignment" (Wikipedia). In this regard, the anonymous author overlooks the al-Azhar and al-Ḥākim Mosques, which have the same orientation as the al-Aqmar Mosque, but these do not lie on the main thoroughfare. The glorious façade of the al-Aqmar Mosque is aligned so that anyone facing it is facing the *qiblat al-ṣaḥāba*, and the inside is facing the *qibla* of the astronomers. As Wikipedia tells us:[714]

> "The novelty of the plan lies in the facade's alignment with the street in contrast with its interior space, which remains oriented towards the qibla. In order to accommodate this difference in angle while still maintaining internal symmetry, the structure uses variations in wall thickness".

Such pronouncements are of no great value (or interest) unless accompanied by a simple sketch. And keep in mind that the anonymous author of this article had a very unclear idea about what the medieval *qibla* for Cairo was. Also, according to the historian al-Maqrīzī, there were, in the time of al-Ḥākim, some 800 mosques in Cairo (and it environs), so we are merely scratching the surface.

In addition to the al-Azhar Mosque and the Mosque of al-Ḥākim, which are oriented in the *qibla* of Ibn Yūnus, although nobody ever mentions this, there are many of religious complexes aligned in that same direction. Christel Kessler identified the mausoleum complexes of the *amīr*

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[714] https://en.wikipedia.org/wiki/Aqmar_Mosque.

Shaykhūn (1349) and the *amīr* Khayrbak (1502),[715] but there are dozens more. Indeed, I would anticipate that this *qibla* of 37° S of E was used until *ca*. 1800, when more accurate geographical data became available, but that is another story.

We now turn to some mosques oriented in the "old", "traditional", *qibla*-direction, associated with the Companions of the Prophet, although this association is something of a mystery.

Mosques aligned with winter sunrise

The religious scholars, on the other hand, appear to have favoured the *qiblat al-ṣaḥāba*, that is, winter sunrise, rather than any computed *qibla*. Some Fatimid religious architecture faces the *qibla* of the *ṣaḥāba*. One example is the *qubba* (dome) opposite the *khānqāh* of Baybars al-Jāshankīr, the dome having been built between 1100 and 1133. The same holds for some Mamluk monuments: Christel Kessler identified the mausoleum of the *amīr* Ulmās al-Ḥājib (1330) and the funerary complexes of Sultan Shaʿbān II (1368) and the *amīr* Qānībāy al-Muḥammadī (1414) as facing the *qiblat al-ṣaḥāba*.[716] As far as I am aware, Kessler never recognized that the whole Fatimid/Ayyubid/Mamluk city was oriented with its main axis perpendicular to the *qibla* of the *ṣaḥāba*. I did try to tell her this, but in vain.

When the Fatimid Caliph al-Muʿizz tried to change the orientation of the Mosque of ʿAmr in 956/57 he encountered considerable opposition, and was made to see the error of his ways by various miraculous happenings.[717]

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715 Kessler, "Funerary architecture within the city" (1972), with clear, properly-oriented plans; cited in Abdulkarim, *Building Craftsmen in Mamluk Society* (2017), p. 60, with plans after Kessler.

716 As in previous note.

717 Creswell, *Architecture of Muslim Egypt*, I (1952), p. 213, quoting the historian al-Bakrī.

The 14th-century Egyptian legal scholar al-Zarkashī, in his book on mosques, states that it is permissible to pray to the right or left of a *miḥrāb* in a mosque, except in the main mosques in Medina, Kufa, Basra, Damascus, and also Fustat, because the Prophet or his Companions prayed in these.[718]

Of course, the actual situation 'on the ground' and away from the main thoroughfare is far more complicated than any medieval Arabic texts will reveal, and there are as many architectural mosque plans that cannot be explained in this way as there are plans that do indeed fit with what we know from the texts. So, for example, Christel Kessler began her investigations with some of the most complicated examples. It would be unreasonable to expect that we can explain all historical mosque orientations, just as it is unreasonable to ignore them altogether.

Amenah Abdulkarim, who is the only scholar who has taken Kessler's findings as seriously as they deserve, and who has compared edifices with one or other of these two principal *qibla* orientations, comments that, regardless of which of these two was the more common, both orientations applied *handasa*, the art of the architect and master-builder, and also astronomy to orient the *miḥrāb*s towards the *qibla*.[719]

The City of the Dead

In Islamic practice the dead are to aligned with the *qibla* so that, on the Day of Judgement, they will rise facing the Kaʿba.[720] The main axis of the Mamluk "City of the Dead",[721] to the east of the Fatimid-Mamluk city, is

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718 al-Zarkashī, *Iʿlām al-sājid bi-aḥkām al-masājid*, p. 363.

719 Abdulkarim, *Building Craftsmen in Mamluk Society* (2017), p. 60.

720 See, for example, the article "Ḳibla (religious aspects)" in *Enc. Islam*, 2nd edn., by A. J. Wensinck.

721 For a reliable introduction see Galila El Kadi & Alain Bonnamy, *La Cité des Morts – Le Caire* and/or *The Architecture for the dead, the medieval necropolis in*

perpendicular to the *qibla* of the astronomers. Therefore, most of the funerary architecture in that region is aligned with both that main axis and the perpendicular *qibla* of Ibn Yūnus.

The testimony of al-Maqrīzī

Now there were indeed more than two *qibla* directions used in medieval Cairo, and this was not lost on the historian al-Maqrīzī, who discussed the divergences of the *miḥrāb*s in Egyptian mosques and identified a total of five different *miḥrāb* orientations – **Pl. U8**.[722] His extensive chapter on the subject is entitled:

ذكر المحاريب التي بديار مصر وسبب اختلافها
وتعيين الصواب فيها وتبيين الخطأ منها

"Statement on (the orientation of) the *miḥrāb*s in the provinces of Egypt and the reasons for their differences, together with an identification of those that are correct and an explanation of those that are false."

Cairo (2007). For a fascinating account, with historical introduction and anthropological insights based on personal experience, see Tozzi Di Marco, "Cairo's City of the Dead: the cohabitation beteeen the living and the dead from an anthroplogical perspective" (2010).

722 See al-Maqrīzī, *al-Khiṭaṭ*, IV, pp. 21-33 (Beirut 'edition', IV, pp. 23-35), mentioned already in the remarkable article "Masdjid [= mosque]" by the Danish Old Testament scholar and Semitic philogist Johannes Pedersen (1883-1977) and others in *Enc. Islam*, 1st edn. (1913-1936):

> "Maqrīzī mentions the different solutions of it in Egypt. The direction was ascertained by the stars."

A summary is presented in King, "Architecture and astronomy" (1984), pp. 114-115 / new version, *Synchrony*, vol. 1 (2004), VIIb: 804-807.

This chapter has never been translated or discussed in detail and I do not propose to do that here. It occurs in the middle of a survey of mosques in Egypt. But what a perfect topic for a doctoral dissertation!

Now al-Maqrīzī was well informed on his subject but his experience was limited to Egypt. We have the advantage of familiarity with mosque orientations in various regions of the Muslim world. al-Maqrīzī is typical of those medieval authors who tend to approve of certain things and disapprove of all others. (The first medieval Arabic text I ever read as a graduate student with Prof. Franz Rosenthal was a book on the 73 sects in Islam – a number allegedly predicted by the Prophet Muḥammad – by Abū Isḥāq al-Isfarā'īnī (d. 1027), in which 72 sects are described and dismissed as false, leaving the author's own sect as the best and only acceptable one.)

First, al-Maqrīzī discussed elsewhere the orientation of the original Mosque of ʿAmr in Fustat toward the east, modified some 70 years later to face winter sunrise.

Second, the *qibla* of the *ṣaḥāba*, namely, midwinter sunrise, which he stated was used for the Mosque of ʿAmr in Fustat, and the congregational (*jāmiʿ*) mosques in Giza, Bilbays, Alexandria, Qus and Aswan.

Third, the mathematically-computed *qibla*, which he stated was used for the al-Azhar Mosque.

Fourth, the *qibla* of the Mosque of Ibn Ṭūlūn, built in 879, that is, after at least some astronomers should have been able to calculate the *qibla*. al-Maqrīzī points out that it faces 14° south of the mathematically-computed *qibla*, namely, that is, 127° + 14° = 141°. He gives two somewhat fanciful explanations of this. One involves a man sent by Ibn Ṭūlūn to Medina to measure the orientation of the Prophet's Mosque in Medina, which he found was "about ten degrees to the south" of the *qibla* "that can be determined by technical means"; as a result, Ibn Ṭūlūn made a similar adjustment for his Mosque in Cairo. The other story is that the Prophet Muḥammad traced out the *miḥrāb* for Ibn Ṭūlūn whilst the latter was asleep.

On the fifth orientation toward the south see below.

At the end of his discussion al-Maqrīzī displays at once both his piety and his lack of understanding of the *qibla* problem by referring to “the correct *miḥrāb*s of Egypt which were laid out by the Companions”.

In various publications (starting with King 1984) I have presented a graphic representation of the information presented by al-Maqrīzī, that is, a range of directions within a quadrant that were used for medieval mosque orientations. These sometimes feature together with similar diagrams for Córdoba and Samarqand, each also displaying information from medieval texts – see **Pls. T14 & U6**. The reader who has seen these diagrams will understand why I react as I do when some misinformed revisionist claims that medieval mosques do not face Mecca, but, rather, somewhere else.

The *qibla* toward the south

In Egypt to this day one often hears the word *‘iblī* for قبلي, *qiblī*, to denote south. The same holds for a swathe of regions from the Maghrib to Iraq. al-Qalqashandī states that the south wind is called *al-qibliyya* in Egypt, “because it comes from (the direction which is) the *qibla* (in Egypt)”. At least for Egypt it is clear where this notion comes from.[723]

The fifth *miḥrāb* orientation observed by al-Maqrīzī was due south or even a few degrees west of south. This orientation, he says, was attested in al-Qarāfa and in “the villages”. The modern maps of Cairo confirm this southerly orientation of religious edifices in the al-Qarāfa area. The reasons which al-Maqrīzī gives for such orientations are, first, that various mosques were converted from churches which faced east and a *miḥrāb* was installed on the south wall; and, second, that the Egyptians were using the same *qibla* as their Syrian ‘neighbours’, namely due south. He also mentions that mosques were built “toward Canopus”, stating that this star rises “a little to the south of the rising point of the sun at mid-winter”,

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723 See the text to n. 844 below.

culminates due south, and sets “at a small inclination to due south”. He adds that “the rising point of Canopus is approximately in the azimuth of the *qibla* for Egypt.” Here al-Maqrīzī combines several errors: first, Canopus rises in Cairo some 40° south of the rising point of the sun at mid-winter; second, it rises and sets at *ca*. 23° east and west of due south; third, its rising point is some 30° south of the mathematically-computed medieval *qibla* for Cairo. However, as we shall see below, because of the orientation of the Kaʿba, the Egyptians had good reason to use either winter sunrise or the rising point of Canopus for orienting their mosques.

al-Maqrīzī did not associate this southern *qibla* with the Imām al-Shāfiʿī (767-820), whose mausoleum near Fustat is still a pilgrimage site. Even in Central Asia the Shāfiʿīs faced south in prayer.[724]

The testimony of Abu ‘l-Manṣūr Fatḥ al-Dimyāṭī

Another Egyptian, the 12th-century legal scholar Abu ‘l-Manṣūr Fatḥ al-Dimyāṭī, wrote a short treatise on the *qibla* in Egypt.[725] In this work, which is essentially an open letter to his colleagues in Damietta, al-Dimyāṭī also discussed the different *miḥrāb* orientations in the mosques of Egypt, but with less useful details than the discussion of al-Maqrīzī. al-Dimyāṭī confessed that he knew that the *qibla* of the Companions was wrong when compared with the *qibla* that could be derived by computation. However, he had been to Mecca and had conferred with scholars there on the part of the Kaʿba which was facing Egypt. They told him that it was the part between the western corner and the water-pipe, and so he stayed up with

724 King, “al-Bazdawī on the *qibla* in early Islamic Transoxania” (1983/86), pp. 7-8.

725 al-Dimyāṭī’s short treatise is extant in the unique copy MS Damascus Ẓāhiriyya 5579 (17 fols., copied 802 H (1399/1400)). It was first discussed in King, “Architecture and astronomy” (1984), p. 123 / *In Synchrony with the Heavens*, VIIb: 806, and is put into context in King, “Finding the *qibla* by the sun and stars” (2019), no. 7.

some other Egyptians at the Kaʿba by night and stood facing that section of the Kaʿba, taking note of various features of the night sky. They found that the north celestial Pole was at the side of the left shoulder and the Pleiades set behind the back, and that Vega (the star النسر الواقع, α Lyrae) set at the right side and Antares (that is, the star قلب العقرب, α Scorpionis) rose on the left side. When they returned to Egypt, al-Dimyāṭī claims, they found that the same phenomena were observable when they faced the *qibla* in the mosque of ʿAmr at Fustat. He concludes that the Companions were right after all.

Now al-Dimyāṭī's astronomical knowledge was such that he apparently did not realize that the night sky at Mecca looks somewhat different from the night sky at Cairo, and that the directions of risings and settings of the sun and stars vary with latitude. Elsewhere in his treatise, he advocated a *qibla* for Egypt which is inclined a little away from the rising point of the sun at mid-winter toward the rising point of Canopus. This is indeed a happy compromise, being halfway between the *qibla* of the Companions and the *qibla* used in early mosques in Qarāfa, and also being closer to the *qibla* of the astronomers.

In 1982 I discovered in the Bodleian Library in Oxford a manuscript – Marsh 592 (120 fols., copied 592 Hijra / 1196) – of a lengthy treatise on the *qibla* by al-Dimyāṭī.[726] It is entitled كتاب التهذيب في معرفة دلائل القبلة ونصب المحاريب, *Kitāb al-Tahdhīb fī maʿrifat dalāʾil al-qibla wa-naṣb al-maḥārīb* (*The Book of instruction on the ways to find the qibla and to set up prayer-niches*). It is, in my opinion, the most important legal treatise on the *qibla* known to us, and I have referred to it in numerous publications. (A full translation was prepared by the graduate students in my Advanced Arabic seminar at New York University in the Spring Semester of 1983 but the entire text was lost in 1985 in intercontinental transit.)

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726 King, "Architecture and astronomy", p. 115 / *Synchrony*, vol. 1 (2004), VIIb: 806 & 817. See now King, "Finding the qibla by the sun and stars", no. 7.

al-Dimyāṭī's longer treatise is full of new information, and it is carefully illustrated, which is very rare for a legal treatise – see **Pl. T3**. It was also one of the sources of al-Maqrīzī's information on mosque orientations, the other being Ibn Duqmāq. Here I refrain from further comment, save to note that the unique manuscript was copied in the same elegant hand as the Bodleian's recently-acquired *Book of Curiosities*, which has attracted a great deal of attention (see below). al-Dimyāṭī's treatise, announced over 30 years ago, will perhaps arouse some interest one day.

Ibn Duqmāq

The history and topography of Cairo by the scholar Ibn Duqmāq (1349-1407) has, alas, eluded me.[727] He wrote a book, كتاب الانتصار, in ten volumes about ten cities in the Muslim world, two of which concern Cairo and Alexandria. This part of the work was edited in Cairo in 1893 by the German orientalist Karl Vollers (1857-1909),[728] long known to me as the cataloguer of the Leipzig collection of oriental manuscripts. (It was thanks to Voller's catalogue of the Leipzig manuscripts that I discovered the medieval corpus of tables for timekeeping for Jerusalem.[729]) Vollers was better known in Egypt as a former director of the Khedival Library (1886-1896). Ibn Duqmāq is generally accepted as having been a source for al-Maqrīzī.

I could not for the life of me find a real copy of Ibn Duqmāq's work in the richest library collection of Islamica in Europe (right here in Frankfurt) or a downloadable copy on the internet, despite several attempts using

727 Article "Ibn Duḳmāḳ" by the Danish orientalist Johannes Pedersen (1883-1997) in *Enc. Islam*, 1st & 2nd edn.

728 Karl Vollers, ed., *Description de l'Égypte par Ibn Doukmak* (1893). I was unable to access this book or to find a copy on the internet, using Arabic and English. I presume we are dealing with an Arabic text and an introduction in French. Somewhere I saw a reference to "Ibn Duqmaq IV 59-67 on mosque of 'Amr".

729 King, "Astronomy in medieval Jerusalem" (2019).

English and Arabic google searches. There are various ridiculous Arabic and English google.books sites where the title comes up but the book is nowhere to be found (despite having been republished several times, even as recently as 2014). Looking for the additional word قبلة , *qibla*, tended to yield references to قبله , *qablahu*, which were of no relevance. Maybe it is simply my ineptitude.

In any case, this book should be available on the internet, but apparently it is not. **Whoever might wish to pursue what medieval historians wrote about orientations in Cairo must consult:**

al-Dimyāṭī —— Ibn Duqmāq —— al-Maqrīzī .

Orientations in Damascus and Jerusalem

The interpretation of mosque orientations is not complicated only in Cairo. We have already referred to the situations in Córdoba and Samarqand – **Pl. T14**. But there are also problems elsewhere in the Mamluk world. Thus there is a tendency amongst various colleagues to think that the *qibla* in Damascus and Jerusalem is south – **compare Pl. T3**. This idea was also held in the medieval period, not least since the principal (that is, the earliest) mosques in each city faced south.[730] It is time to recognize that for each city there was more than one main direction used for the *qibla*: the southerly direction proposed by tradition, the various *qibla*s proposed over the centuries by the proponents of sacred geography, and the various but similar *qibla*s proposed over the centuries by the astronomers. Add to these the modern *qibla*s, irrelevant though they may be for the study of historical architecture. In each case, we are talking about cites oriented with respect to the Kaʿba. It is up to us to try to understand how this was achieved.

Orientations in Kufa, Baghdad, Wasit and Greater Syria

[730] See n. 745.

> "The whole plan (of Kufa) was oriented according to the cosmos. In the case of pre-Islamic Mecca, [the direction of sunrise at?] the spring equinox, symbolized by the location of the Black Stone [?], dictated the orientation. The apparent deviation of the present location of the Black Stone from its original position [?] can be explained by the precession of the equinoxes [!]. If this deviation is accurate, then the original orientation may have been in Hellenistic times." Ibrahim Allawi, "Some evolutionary and cosmological aspects to early Islamic town planning" (1988), p. 58.

A symposium was held in November 1987 by the Aga Khan Program for Islamic Architecture at Harvard University and the Massachusetts Institute of Technology, Cambridge MA. It was entitled "Theories and principles of design in the architecture of Islamic societies", and the organizer was the American historian of Islamic art, Margaret Sevcenko (1931-2002).[731] I had just moved to Frankfurt, but had I been able to attend that conference I would have probably made a presentation about the city-plan of medieval Cairo. If that had happened, I should not be writing this monograph now. Coincidence plays a significant role in the writing of history.

As it was, Ibrahim Allawi, a scholar whom I have been unable to identify, presented an imposing and novel paper on cosmological aspects of the planning of Kufa and Baghdad, using mainly scientific sources, such as the *Astrological History* of Māshā'allāh and al-Bīrūnī's *Chronology*.[732] Allawi presents an imposing amount of astrological calculations, but he is not in control of some of the basic astronomical concepts. It is sometimes impossible to establish the origin of the data for his calculations, even though his footnotes and references are impeccable, but in any case for the average historian they will be difficult if not impossible to follow. The

[731] The proceedings are available in Sevcenko (Ševčenko), ed., *Theories and Principles of Design in the Architecture of Islamic Societies* (1988).

[732] Allawi, "Some evolutionary and cosmological aspects to early Islamic town planning", in Sevcenko, ed., *Theories and Principles ,,,* (1988), pp. 57-72.

materials should ideally be investigated afresh, by someone with the appropriate qualifications. As far as I am aware, Allawi's study has apparently inspired only one other scholar, the British archaeoastronomer Nicholas Campion, who was fortunately able to also cite George Saliba's valuable study of the rôle of the astrologer in Islamic society.[733]

Ibrahim Allawi, in a quotation cited above, claims the Black Stone in the Kaʿba is aligned with the spring equinox. It is true that the south-east corner, where the Black Stone is situated, faces roughly due east, but is difficult to see how either Kufa, a "rotating square" (?), or Baghdad, a round city including a central palace and an adjoining mosque, both *qibla*-oriented, could have had anything to do with the Black Stone. ... ... Unless, of course, the *qibla* at Baghdad was taken as being the same as if one were standing in front of the Kaʿba facing toward the south-east corner of the edifice with the Black Stone, which would mean that one should face more or less due west, and the *qibla* at Baghdad should also be due west, which it was not.

Which direction would have been taken as the *qibla* at Baghdad before the astronomers in the early 9th century calculated it sensibly from the available geographical coordinates as 13° W of S?[734] If the province of al-ʿIrāq had had a *qibla* towards the south-eastern or "ʿIrāqī" corner of the Kaʿba, this would have meant the direction one was facing when standing in front of that corner; this would explain a *qibla* of due west. We must turn to the schemes of sacred geography relating each region of the world with a segment of the perimeter of the astronomically-aligned rectangular

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733 Nicholas Campion, "Archaeoastronomy and calendar cities" (2016), using also Saliba, "The role of the astrologer in medieval Islamic society" (1992).

734 On early geographical coordinates for Baghdad see Kennedy & Kennedy, *Geographical coordinates of localities from Islamic sources* (1987), p. 55, and on those used in the earliest *qibla* determinations see King, "The earliest Islamic mathematical methods and tables for finding the direction of Mecca" (1986), pp. 126-129.

Kaʿba.[735] Thus for finding the *qibla* by the sun and stars, the earliest known scheme of sacred geography, associated with the geographer Ibn Khurradādhbeh (Baghdad, late 9th century), has al-ʿIrāq associated with the north-eastern wall of the Kaʿba with a *qibla* between east and north. The Yemeni scholar Ibn Surāqa (Basra *ca*. 975), who more than anyone else was responsible for the formalization of the sacred geography of later centuries, has for Central al-ʿIrāq the segment of the north-eastern wall between the *Muṣallà* of Adam and the door, which would involve a *qibla* toward winter sunset. Allawi's statements about the ascendant of Baghdad (Sagittarius 6°) and the *qibla* there should perhaps be investigated in the light of what we now know about the ways the *qibla* was determined in those times.[736]

We have one splendid example of a mosque in al-ʿIrāq which was erected in one direction in 703 and then pulled down a few centuries later and re-erected in a different direction. This is the Mosque at Wāsiṭ, for which we have the splendid plan published in 1934 by the Iraqi archaeologist Fuad Safar (1911-1976) – **Pl. T15**.[737] Various proposals have been made about the first mosque, namely, that it faced Jerusalem (Creswell) or some imagined unidentifiable Hagaritic shrine in N.W. Arabia (Cook & Crone).[738] More recently we have been presented with an even more absurd

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735 The information in this papagraph is taken from the diagrams and tables in the article "Makka as centre of the world" in *Enc. Islam*, 2nd edn. On the schemes of Ibn Khurradādhbeh (sensible) and al-Muqaddisī (impractical) see also Schmidl & Herrera, "The earliest Islamic schemes of sacred geography" (2008). On the known sources for this tradition see King, "Finding the *qibla* by the sun and stars – Islamic sacred geography" (2019/2020), with Ibn Surāqa at no. 4.

736 Allawi, "Evolutionary and cosmological aspects" (1988), pp. 63 and 67.

737 Fuad Safar, *Wāsiṭ, the sixth season's excavations* (1945).

738 Ettinghausen & Grabar & Jenkins-Madina, *Islamic Art and Architecture 650-1250* (1987, 2nd edn., 2001), p. 306, n. 55, call Crone & Cook's ideas "intriguing and probably incorrect". They are completely demolished in various writings of

pronouncement that this mosque deliberately "points directly between Petra and Mecca, with less than one degree of accuracy" (Dan Gibson).

The British scholar of the Art & Archaeology of the Islamic Mediterranean, Jeremy Johns, in his 2003 article about archaeology and the early history of of Islam, presents the plan of the two mosques but more to criticize Cook & Crone than to develop new insights into the *qibla* in early al-ʿIrāq.[739]

In this case, we can only hope that the direction compass on Safar's plan is more or less accurate. Safar himself stated that the (first) mosque is at 231° measured from magnetic north.[740] The magnetic declination was about 3° E at Wasit in Safar's time,[741] so that the compass pointing north (magnetic) would actually be pointing 3° E of true north. Therefore, **the**

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mine; see, most recently, King, "Finding the *qibla* by the sun and stars" (2019), p. 45.

739 Johns, "Archaeology and the history of early Islam: The first seventy years" (2003), pp. 414-415. Johns gives 231° and 197° for the two orientations, but these are measured with a compass. On the *qibla* his sources are only Cook & Crone and, for "a more balanced discussion of the problem", pp. 560-573). For a less balanced account see Gibson, *Early Islamic Qiblas* (2017), pp. 42-43.

The article "Makka as centre of the world" in *Enc. Islam*, 2nd edn., which mentions the earliest *qibla*s for al-ʿIrāq, defined in terms of astronomical horizon phenomena, is overlooked by all these authors.

On some recent comments on the mosques at Wāsiṭ see King, "From Petra back to Mecca" (2017), pp. 19-20.

740 Safar, *Wāsiṭ, the sixth season's excavations* (1945) (not seen), p. 20, 29, n. 8, cited in Hoyland, *Seeing Islam as others saw it* (1997), p. 568, n. 98.

741 To determine magnetic declination for any time and place, see www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#declination. In the old days, people used to measure orientations with a magnetic compass regardless of (or in total ignorance of) magnetic declination.

orientation of the mosque would be 234°. Now this is within about 5° of winter sunset. To assess the orientation of an early mosque in terms of the rising or setting of the sun or a particular star one should always take into consideration the elevation of that part of the horizon, and we cannot do that here. Robert Hoyland has 231° / ∅ and Johns has 232° / 197°, but these are measurements from magnetic north. Gibson has 235° / ∅. Hoyland states that this value 231° "deviates from the true *qibla* by 33 degrees", showing that even he falls into the trap of thinking that the modern *qibla* is relevant to a historical mosque.

The orientation of the first mosque I would interpret as winter sunset (*ca*. 240°), the direction in which one stands when standing in front of the north-eastern wall of the Kaʿba. The orientation of the second mosque is based on a mathematically-computed *qibla* (*ca*. 195°), using the available medieval geographical coordinates, whereby one should bear in mind that the relevant contemporaneous *qibla* for Baghdad is about 193° in early sources.[742] The modern *qibla* for Wāsiṭ is irrelevant to the history of the mosques.

Thus Crone & Cook and after them Hoyland and Gibson have been posing the wrong question: where do these mosques face? The question to pose is: how were these mosques laid out, given what we know about the means for finding directions of distant edifices/locations that were available at the time? To that the answer, at least for the 7th and 8th centuries, but also, in some cases, thereafter, is: astronomical alignments.

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[742] King, "Earliest *qibla* methods and tables" (1986/1993), pp. 127-129; "Too many cooks ... A new account of the earliest Muslim geodetic measurements" (2000), p. 228.

For some early Islamic sites in Jordan and Syria the orientations have been recorded by the archaeologists Patricia Carlier and Alastair Northedge.[743] These perhaps need to be reassessed in the light of the fact that modern *qibla*s are irrelevant. Robert Hoyland says of them:[744]

> "Certainly in Syria increased precision was achieved (in determining the *qibla*): the mosques at ʿAmmān, al-Kharāna, Jabal Says, Qaṣr al-Ḥayr al-Sharqī, Qaṣr al-Ḥayr al-Gharbī and Ruṣāfat Hishām are all oriented towards Mecca with an error of 9 degrees or less, the deviation becoming smaller as time went on."

This would be very commendable if the *qibla*s had been calculated. But they were not. As far as we know, nobody was computing *qibla*s anywhere until the early 9th century.

In an entire book devoted to the building of mosques in early medieval Syria, the Italian scholar of Islamic art and civilization, Mattia Guidetti, mentions no direction for the *qibla* of these mosques other than due south.[745] I find it curious that no medieval discussion is known of the need to switch from this traditional *qibla*, imposed by the cardinal orientation of a Roman temple converted to a Byzantine church converted to a mosque, to a 'real' *qibla* based on computation. It was, after all, in Damascus that the most serious calculations of the *qibla* for all longitudes and latitudes were conducted in the mid 14th century.

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743 Patricia Carlier, "Qastal al-Balqa': An Umayyad site in Jordan", and Alastair Northedge, "The Umayyad mosque of ʿAmman", both published in the proceedings of the 1989 Amman conference on the history of Greater Syria (not available to me).

744 Hoyland, *Seeing Islam as others saw it* (1997), p. 569.

745 Guidetti, *In the Shadow of the Church: The building of mosques in early medieval Syria* (2016).

Certain orientations in greater Syria are problematic, not only in comparison with orientations elsewhere, but because they do not correspond to what we might expect.[746]

[746] King, "The Petra fallacy" (2018).

(16 — Excursus: Cairene orientations in the modern literature)

What to say when one is not quite sure how they did it

"Le bâtiment ayant été disposé d'après la direction de la Mecque, il s'en suit qu'aucune partie n'est orientée suivant les points cardinaux. (Note : Malgré cette non orientation d'après les points cardinaux, pour nous conformer à la désignation usitée chez le peuple égyptienne et adoptée par el-Makrîzî, nous désignerons les liouâns par les indications de liouân est, ouest, nord et sud. Il est de même pour les planches jointes à l'ouvrage.)" / "(The Mosque of Sultan Ḥasan) having being laid out in accordance with the direction of Mecca, it follows that no part of it is oriented in the cardinal directions. (Footnote: In spite of this non-orientation in the cardinal directions, in order to conform with the designation current amongst the Egyptians and adopted by al-Maqrīzī, we shall designate the *īwān*s as east, west, north and south *īwān*s. The same convention will be used for the plates attached to this work." Max Herz, *La Mosquée de Sultan Hassan au Caire* (1899), p. 1. (A very sensible approach, although each *īwān* faces between two directions and is named after one. At least Max Herz was consistent in his choice of nomenclature and was well able to justify it.)

"(The Grand Mosque of Córdoba) is set, as nearly as can be measured, exactly north and south, although the direction of Mecca from Cordova is 10°14′ S. of E.'' K. Archibald C. Creswell, *Early Muslim architecture*, II (1940), pp. 145-146, repeated in *idem*, *A short account of early Muslim architecture* (1958 edn.), p. 216. (With these words Creswell initiated decades of nonsensical remarks about the significance of the orientation of the Mosque, which actually faces 30° E of S. The modern *qibla* is, of course, irrelevant in any discussion of a historical mosque.)

"In a properly orientated mosque the entire wall which faces the Black Stone [!!] in Mecca – the so-called qibla wall – serves as a directional indicator. It thereby makes the mihrab superfluous [!!]."

Robert Hillenbrand, *Islamic architecture – Form, function and meaning* (1994), p. 46. (This kind of nonsense was not to be expected from the author of a book with this imposing title.)

" ... cases of the faulty orientation of religious buildings are legion in medieval Islam ... ." *Ibid*., p. 181. (It is Hillenbrand's interpretations of orientations that are at fault here, rather than the orientations.)

"Most striking of all, though, is the choice of a *qibla* direction (for the Grand Mosque in Córdoba) facing due south [*sic*] – a direction which at Damascus was accurate [*sic*] but which at Cordoba pointed at Ghana [*sic*] rather than Mecca. Furthermore, this grossly erroneous *qibla* [*sic*] was maintained without change in all the subsequent enlargements of the mosque, even though each such enlargement offered another opportunity to correct it. This *qibla* therefore functioned as a continuous reminder of the Syrian heritage [*sic*]. Yet by the time of the final enlargement of the mosque in the late 4th/10th century these multiple references to the Damascus mosque were old-fashioned; mosque design had moved on." Robert Hillenbrand, "The Great Mosque of Córdoba" (1992), pp. 130-131. (The orientation of the Córdoba Mosque was not due south, and it had nothing to do with the orientation of the Great Mosque in Damascus.)

"Any space intended for prayer (in Cairo) had to be oriented towards the qibla, and patrons required that such elements as tombs, minarets, and portals be displayed on the street façade, which was usually at some variance to the direction of Mecca." Sheila S. Blair & Jonathan M. Bloom, *The Art and Architecture of Islam 1250-1800* (1994), p. 70. (The authors overlook the fact that the minor axis of the orthogonal street-pattern of Fatimid/Mamluk Cairo was propitiously aligned with what was called the *qibla* of the Companions of the Prophet.)

" ... the Khanqah-Madrasa of Ahmad al-Mihmandar (1325) ... ... has a long, straight façade along the street, which was possibly because the designers decided to ignore the correct *qibla*

orientation and to instead adhere to the street alignment (the *qibla* direction is off by about 30°, a tremendous deviation even in a city with several known and sanctioned *qibla* orientations).” Nasser Rabbat, *Staging the City: Or how Mamluk architecture coopted the streets of Cairo* (2014), p. 22.

It is commonplace amongst historians of Islamic architecture to make silly pronouncements such as “this mosque is not facing Mecca” or “that mosque is incorrectly aligned toward the *qibla*”. What they generally mean is the modern direction of Mecca or the modern *qibla*. But a little reflection should show that such mosques cannot be expected to be aligned in the modern *qibla*. Nor can many historians of Islamic architecture claim to know anything of consequence about what the medieval Muslims thought was the *qibla* in various localities, unless they are familiar with some of the necessarily regional medieval literature on the subject.

The mosques themselves are trying to tell us something about what the people who built them took as the *qibla*. All Islamic religious architecture is “Mecca-oriented” in one way or another. That does not mean that in any one locality all the mosques will be facing the same direction. To be more precise, the mosques are oriented toward the Kaʿba in Mecca – Pls. U9, U10 & U7. If one knows nothing about the Kaʿba, one cannot understand the *qibla* as the Muslims conceived it centuries ago. It is important for us moderns to remember that this architecture is oriented in the direction ‘they’ took as the *qibla*, not in what ‘we’ think the *qibla* was or should have been. And I repeat for the thousand and oneth time: <u>modern</u> *qibla* directions are irrelevant in any discussion of <u>medieval</u> architecture. It’s about them, not about us.

For architecture historians decades ago, there was indeed a problem that few knew how to overcome, namely, that they had to measure the orientation of buildings with a magnetic compass. But the compass gives only a measure of direction from magnetic north, and the magnetic declination (the angle from magnetic north to true north) varies according

to place and time. The difference between the two might be substantial.[747] In addition, obtaining a reputable reading for a mosque orientation was an art in itself. The first historian of Islamic architecture who actually related how he derived the orientations in his plans was, I think, the American scholar, Myron Bement Smith (1897-1970), who concentrated on architecture in Iran.[748]

The early-20th-century specialists on Islamic architecture, of whom I will mention only Archie Creswell and Gaston Wiet, were not ready for any investigation of Cairo orientations, although at least Creswell put a directional indicator on most of his published plans. Measuring orientations carefully and markings plans properly should have been the duty of the following generation.

The reader will not learn much about Cairo orientations in this section, but occasional maps and plans in the literature mentioned are useful when they have proper directional indicators.

In a 2012 article entitled "What is Islamic architecture anyway?",[749] the doyen of the history of Islamic architecture in the U.S., Nasser Rabbat, overlooked one of the most obvious answers: it is architecture that is oriented toward the Kaʿba. How this was achieved is another matter. Cairo provides just one example of a medieval Islamic city where a palette of *qibla* directions was used to align religious architecture toward the Kaʿba, but it is arguably the most remarkable example.

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747 See Barmore, "Turkish mosque orientation and the secular variation of the magnetic variation" (1985), for a study of historical orientations in order to determine magnetic variation, a somewhat risky operation.

748 See https://sova.si.edu/record/FSA.A.04 on Smith's archives. See also King, *Synchrony*, XVII: 767, for an appreciation and an article on the quatrefoil as decoration on Islamic astrolabes from the 10th century onwards dedicated to Myron B. Smith's memory.

749 Rabbat, "What is Islamic architecture anyway?" (2012).

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These remarks and the overview of the literature that follows should not be taken simply as criticism of colleagues in the history of Islamic architecture in Egypt. The same problems are found in writings on Islamic architecture from al-Andalus and the Maghrib in the west to Central Asia and the Indian subcontinent and South East Asia in the east to Yemen in the south.

If, or because, historians of Islamic architecture have not paid much attention to the sacred direction, historians of medieval urban development tend not to either. Thus Howayda Al-Harithi in her 2001 article "The concept of space in Mamluk architecture",[750] and even André Raymond (1925-2011), perhaps the leading authority on urban development and society in medieval Cairo, whilst writing in 2003 on urban development in Mamluk times using dozens of mosques as examples, did not mention the *qibla*.[751] Other writers on urban development in medieval Cairo who did mention the *qibla* are discussed below. The same holds for their colleagues working on other regions of the Near East, who hardly ever mention the *qibla* in their deliberations.

Individual scholars

Christel Kessler

In the 1960s and '70s and '80s, the Cairo-based German historian of Islamic architecture Christel Kessler, the leading disciple of Archie Creswell, realized the importance of orientations in medieval Cairene architecture and published several papers thereon. Her theme was the

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750 Howayda Al-Harithi, "The concept of space in Mamluk architecture" (2001).

751 André Raymond, "Al-Maqrīzī's *Khiṭaṭ* and the urban structure of Mamluk Cairo" (2003). I am confident that André was aware of the importance of the *qibla* in medieval Cairo because we discussed it at the Giorgio Levi Della Vida Conference at U.C.L.A. in 1999.

"Mecca-oriented architecture" which she had detected within the framework of the Fatimid city but internally aligned at an angle to the street-pattern. In her earliest publications she was not aware of complicated situation regarding the *qibla* in medieval Cairo.[752] We had several discussions in Cairo during the 1970s but I failed to convince her that all of the medieval religious architecture in Cairo (and even the city-plan) was somehow oriented toward the Kaʿba. Also, I could not persuade her to drop the designation "Mecca-oriented" / "not Mecca-oriented". In her later research she came to appreciate the importance of al-Maqrīzī's pronouncements and was able to recognize "the *qibla* of the astronomers". She could not believe that there was, in addition to al-Maqrīzī, a corpus of astronomical and folk astronomical and legal material which had been previously unknown that was also extremely relevant.

Thus, at least in her later papers on this subject, Christel recognized the importance of the directions 117° and 127°, even marking both on architectural plans. This having been said, it is a fact that, as observed by Christel, certain medieval religious complexes contain *miḥrāb*s oriented in different and mysterious directions within the same complex. What is also sad is that whilst many of the scholars of the next generation cite her work by title, only one, Amenah Abdulkarim, seems to have really understood it and to have realized its importance – see below.

I would still maintain that any discussion of this subject by architecture historians who are still innocent of what the *qibla* in medieval Cairo was actually thought to be by the people who built the mosques, is doomed to

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752 Kessler, "Mecca-oriented architecture and urban growth of Cairo" (1967); "Funerary architecture within the city" (1972); "Mecca-oriented urban architecture in Mamluk Cairo: The Madrasa-Mausoleum of Sultan Shaʿbān II" (1984); "Mecca-oriented architecture within an urban context: On a largely unexplored building practice of medieval Cairo" (1983); "Mecca-oriented building in mediaeval Cairo" (1984); and "The 'Imperious Reasons' that flawed the minaret-flanked setting of Sulṭān Ḥasan's Mausoleum in Cairo – Another note on medieval Cairene on-site planning according to street-alignments and Mecca-orientations" (1999).

be problematic.[753] But one should not forget that the *qibla* is not the direction of Mecca but the direction of the Kaʿba. The direction of the Kaʿba was found by considering the Kaʿba and the position of oneself with respect to it; this is the *qibla* of those who favoured sacred geography and astronomical horizon phenomena. From the early 9th century onward the astronomers could calculate the *qibla* by exact and/or approximate mathematical procedures applied to the medieval geographical data that was available. Neither of these procedures will produce the modern *qibla*. That is why historical mosques do not face the (modern) direction of Mecca, but they are all Kaʿba-oriented nevertheless.

Suliman Bashear

We have already mentioned in **Ch. 15** the pioneering study of Suliman Bashear on the earliest *qibla* in Egypt in the more general context of early *qibla*s toward the east.[754]

The wretched one

I allow myself some space here in order to mention how the situation regarding historical investigations of the *qibla* changed in the 1970s. This will help to emphasize the fact that Egypt is only one of numerous regions of the Islamic world for which the *qibla* situation is of historical importance.

In 1969, my future doctoral advisor at Yale, Bernard Goldstein, guided this new student (from the Department of Near Eastern Languages and Literatures visiting the the Department of the History of Science and Medicine) towards Arabic scientific manuscripts. My first term paper for

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753 For example, Fernandes, "The foundation of Baybars al-Jashankir" (1987), p. 32, discussion of the *qibla* based on Kessler.

754 Bashear, "Qibla *musharriqa* and early Muslim prayer in churches" (1991), esp. p. 268.

him was a survey of mathematical methods used by Muslim astronomers for determining the times of and direction of prayer, based mainly on the writings of Carl Schoy (1877-1925) and Ted Kennedy (1912-2009), who themselves had worked only on the primary sources.

One of the first Arabic manuscripts I ever looked at in 1970 contained al-Khalīlī's universal *qibla* table. This not only blew my mind, but it marked a new stage in the research already conducted by my predecessor Carl Schoy, who had published several studies of *qibla* determinations by Muslim scientists as well as the survey article "Ḳibla (astronomical aspects)" in the first edition of the *Encyclopaedia of Islam*.[755] Also, my teacher at the American University of Beirut during the year 1970-71, but also thereafter for life, Ted Kennedy, published in 1973 a commentary on al-Bīrūnī's monumental book on the *qibla*, the most important single work on the *qibla* ever compiled by a Muslim scientist.[756]

In 1979 I contributed the article "Ḳibla (astronomical aspects)" to the second edition of the *Encyclopaedia of Islam*. At the end of this heavily technical discussion I ventured a remark to the effect that some historical mosques do not face Mecca in the way one would expect they might. Shortly thereafter I uncovered a whole corpus of new materials on sacred geography and the determination of the *qibla* by means of astronomical horizon phenomena. In 1987 I was able to contribute the article "Makka as centre of the world" to the *Encyclopaedia* so as to present an overview of Islamic sacred geography.[757]

During my later studies of the *qibla* and orientations I was fortunate to be in contact with two colleagues and friends who were also working on the

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755 Article "Ḳibla" in *Enc. Islam*, 1st edn., alas not reprinted in Schoy, *Beiträge*.

756 See Kennedy, *A commentary upon al-Bīrūnī's* Taḥdīd nihāyāt al-amākin (1973).

757 Both reprinted in *Astronomy in the service of Islam* (1993), along with the article "Mīḳāt" on the regulation on the times of prayer.

same subjects. First, the American historian of Near Eastern geography Michael Bonine (1942-2011), who over several decades published fundamental articles on the orientation of cities and mosques in Iran, Tunis and Morocco.[758] Second, the Barcelona orientalist Mònica Rius, whose 2000 doctoral dissertation cast new light on the determination of the *qibla* in al-Andalus and al-Maghrib as revealed by previously-unstudied folk astronomical and legal texts.[759]

Over the years I have published detailed accounts of the *qibla* in medieval Córdoba, Cairo and Samarqand, based on newly-discovered manuscripts,[760] as well as a book on the *qibla* in Iran focussing on Safavid world-maps for finding the direction and distance to Mecca.[761] As a humble continuation of the work of Ted and Mary-Helen Kennedy, who in 1987 published all available Islamic tables of longitudes and latitudes (some 14,000 pairs of entries),[762] I edited the enormous tables of geographical coordinates for hundreds of localities with additional *qibla*-values from

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758 Bonine, "The Morphogenesis of Iranian cities" (1979); "The sacred direction and city structure: A preliminary analysis of the Islamic cities of Morocco'' (1990); "Romans, astronomy and the *qibla*: urban form and orientation of Islamic cities of Tunisia'' (2008).

759 Rius, *La Alquibla en al-Andalus y al-Magrib al-Aqsà* (2000).

760 For Cairo see the 1984 study "Architecture and astronomy: The ventilators of medieval Cairo and their secrets", and for the other locations, "al-Bazdawī on the *qibla* in early Islamic Transoxania" (1983/86) and "The enigmatic orientation of the Grand Mosque in Córdoba" (2019).

761 *World-Maps for finding the direction and distance to Mecca* (1999).

762 Kennedy & Kennedy, *Geographical coordinates from Islamic sources* (1987). Values of the qibla were not generally contained in the geographical tables featured in this survey, and so where they did appear (only in the tables of al-Khāzinī and al-Khalīlī?) they were omitted in the Kennedys' printout.

Timurid Central Asia and Mamluk Egypt and Syria.[763] In particular, a Mamluk table for localities in Syria and Palestine[764] and an Ottoman table for localities in the Ottoman Empire were to be of interest for investigating mosque orientations.[765] I also published general articles on historical mosque orientations as they can be understood from medieval folk astronomical and astronomical and legal texts.[766]

J. Michael Rogers

Michael Roger's presented some brief remarks about the orientations of specific, lesser-known Mamluk buildings in Cairo in relation to surrounding street-patterns in his 1974 article "al-Ḳāhira (= Cairo)" in the *Encyclopaedia of Islam*.[767] These should be taken seriously, but it exceeds our present goal to investigate them here. On the other hand, Michael was unaware of what the medieval *qibla* / *qibla*s was / were, and so the individual buildings he mentioned (and many others) need to be looked at again. He doubtless discussed orientations elsewhere.

Along the streets of medieval Cairo

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763 *World-maps*, pp. 149-161 & 456-477 for the Timurid table and pp. 76-84 & 600-619 for the Mamluk ones.

764 *World-maps*, pp. 84-86 & 620-621, also "A geographical table from 14th-century Damascus with *qibla* values for localities in Mamluk Syria and Palestine" (2019).

765 *World-Maps*, pp. 86-87 & 622, also "An Ottoman list of *qibla*-values for localities in the Ottoman Empire" (2019).

766 Risking repetition, these are "Astronomical alignments in medieval Islamic religious architecture" (1982); "The orientation of medieval Islamic religious architecture and cities" (1995); "The determination of the sacred direction in Islam" (1995); and "The sacred geography of Islam" (2005); and "Finding the *qibla* by the sun and stars" (2019).

767 Rogers, article "al-Ḳāhira" in *Enc. Islam*, 2nd edn., IV (1978), p. 432.

In 1981 Nezar Al Sayyad published a ground-breaking study of the development of medieval Cairo, aptly entitled *Streets of Islamic Cairo – A configuration of urban themes and patterns*.[768] The author brings together a wealth of information in a very palatable form, and treats each period in succession by dynasty. He mentions numerous times "the *qibla* direction" but never actually defines it. There is no indication that in Fatimid Cairo, already by the year 1000, two *qibla*s were involved, or that the Fatimid city was oriented in the *qiblat al-ṣaḥāba*. On the subject of orientations only an early work (1967) by Christel Kessler on "Mecca-oriented architecture and the urban growth of Cairo" is cited. Al Sayyad's book marked the beginning of a trail of such studies, of which the work by Lucy Seton-Wilson below is a rare exception to the rule.

In his 2011 book *Cairo – Histories of a city*, Al Sayyad takes us on a personal journey. This is eminently readable and well documented with maps and illustrations.

Lucy Seton-Watson

Lucy Seton-Watson in her Master's thesis *The development of the Darb al-Ahmar* submitted at the American University in Cairo in 2000 does discuss the *qibla* of various buildings along a main thoroughfare of medieval Cairo, but she does not define what the *qibla* is within the context of medieval Cairo.[769] Thus for her this medieval edifice is "perfectly aligned to the *qibla*" and that medieval mosque is "in perfect *qibla* alignment", but elsewhere "an archaic version of the *qibla* has been used". Even when there is mention of an actual direction for the *qibla* (127° and 117°), no explanation is forthcoming. But at least no reference is made to the irrelevant modern *qibla*, which is what flaws many a

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768 Al Sayyad, *Streets of Islamic Cairo: a configuration of urban themes and patterns* (1981).

769 Seton-Watson, *The development of the Darb al-Ahmar* (2000). See, for example, pp. 54, 79, *etc*., and especially p. 100, p. 345.

modern commentary on medieval orientations from one end of the Muslim world to the other. The author follows Christel Kessler in her concern that the orientation of buildings is important and therefore her work marks something of a step forward.

Renata Holod

In **Ch. 10** we mentioned the unique 1986 article by Renata Holod in which she presented both a 14th-century construction diagram for constructing a *bādahanj* and poems from the 11th to 14th century extolling the virtues of the omnipresent *bādahanj*es. As pleasing as this may be, at least for the present author, Holod continued, now emphasizing the importance of scientific literature for understanding what is, again at least for this author, the most distinctive and important feature of Islamic architecture (my emphasis):[770]

> "The realm of the history of science promises to contribute to the discourse on Islamic architecture. Researches into the history of astronomy and in particular into the computation of the *qibla* are seminal, as they reveal the myriad problems of establishing the *qibla* for mosques, the participation of the scientific community, particularly of the astronomers in this and the complimentary use of folk astronomy and the traditions of the Companions**. Underlying all major architectural schemes then was a sense of sacred directionality which needs to be factored into any discussion of Islamic architecture.**"

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The different means that were used in medieval times for determining the *qibla* are referred to in the above statement. Most colleagues in the history of architecture would just say "The *qibla* is the direction of Mecca", without reflecting long enough to realize that this simple and simplistic

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770 Holod, "Defining an Art of Architecture" (1986), esp. p. 29.

definition is problematic. At most it holds for the last 100 years or so. But **the medieval *qibla*s for each major locality – yes, there were several for each locality – are not the same as the modern *qibla*.** And **the *qibla* is not toward Mecca, it is toward the Kaʿba**. Until now, 2020, as in the time of the above statement 35 years ago, **this sacred directionality has not been factored into any discussion of historical Islamic architecture**. This is one reason why cranks are able to claim that early mosques face somewhere other than Mecca. In a nutshell: the earliest mosques do not "face Mecca" and they do not "face" anywhere else. They face the appropriate corners and walls of the Kaʿba according to the singular prescriptions of Islamic sacred geography, which is based upon the fact that the Kaʿba is astronomically aligned. It is much more complicated than historians of Islamic architecture can imagine, and more complicated that the *revisionistas* will ever (want to) comprehend.

Michael Meinecke

Michael Meinecke, in his monumental study of Mamluk architecture in Cairo and beyond included some 150 plans of religious architecture, all provided with directional indicators.[771] There is alas no indication of the method used to orient the plans, and no discussion of the orientations.

Jonathan Bloom

Jonathan Bloom is a colleague from our Cairo days. In the late 1970s my wife Patricia and I saved his life, an act which he still gratefully acknowledges. We surely must have had discussions about the *qibla* in Cairo during his recuperation at our home in Zamalek, and Jonathan happily recuperated nevertheless.[772]

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771 Meinecke, *Die Mamlukische Architektur in Ägypten und Syrien (648/1250 bis 923/1517)* (1992).

772 Bloom, "Mamluk art and architectural history: A review article" (1999).

In spite of all this, in his seminal 1999 review article “Mamluk art and architectural history”, Jonathan forgot to mention orientations and the *qibla*, let alone the wind-catchers. Happily, in his 2007 article on “sacred space” in Fatimid Cairo, he became the first historian of Islamic architecture to have realised the importance of recent studies of the *qibla* in Cairo for understanding a highly significant feature of its architecture.

> “All scholars agree that the Mosque (of al-Ḥākim) was originally a rectangular enclosure measuring roughly 85 by 69 m. K. A. C. Creswell, who measured the mosque, noted that it is oriented to a *qibla* reckoned 40° south of east (130°), which conforms to neither the *qibla* of the Mosque of Ibn Ṭūlūn (141°) nor the *qibla* of the Mosque of ʿAmr (117°), also known as the *qibla* of the Companions of the Prophet (*ṣaḥāba*). Instead, it is close to 127°, the *qibla* computed by the Egyptian astronomer, Ibn Yūnus (d. 1009), which suggests that the Fatimid general was concerned to establish the scientifically correct orientation, much as he had been concerned with establishing the scientifically correct time to end the Ramaḍān fast.”

A footnote takes the reader to my 2005 study “The orientation of medieval Islamic religious architecture and cities” (p. 264). Here Jonathan acknowledged that the orientation of the al-Azhar Mosque was the same as the *qibla* computed by Ibn Yūnus (as was the identical orientation of the al-Ḥākim Mosque, which he had overlooked in an earlier study). Later he even mentioned the orientation of the Pharaonic / Roman Red Sea Canal, which he claimed to be 20° E of N (rather than *ca*. 27 E of N), alongside which the new Fatimid city of al-Qāhira with its orthogonal *qibla*-oriented street plan was built, albeit without reminding us that the minor axis of the latter is oriented perpendicular to the *qiblat al-ṣaḥāba*.[773] This nevertheless represents a substantial step forward for the field of the history of Islamic architecture.

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[773] Bloom, “Ceremonial and sacred space in early Fatimid Cairo” (2007), pp. 99-100 and 105.

Jonathan in 2009 authored a most interesting article focussing on historical architects's plans for planned monuments, of which several survive. He ventured into the world of mathematical cartography but, alas, without my guidance, for I could have pointed him to more impressive "gridded maps" from the Silk Road. Also, mathematical orthogonal grids, like modern graph-paper, are first attested in 10th-century Baghdad.[774]

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Here I insert a familial reference to an architectural orientation in faraway Iran, which is another example of the way in which orientations should be investigated, namely, in the light of the available textual evidence. In 1985, Jonathan's closest colleague, Sheila Blair, published a detailed study of the early-13th-century Madrasa of Zuzan, 250 km south of Nishapur and 300 km west of Herat. She mentions that an earlier researcher, the renowned French played some role here in Zuzan. But Zuzan is a long way from Samarqand, and the Hanafis used due west for the *qibla* because the road to Mecca left Samarqand in a westerly direction. On the other hand, the *Madrasa* at Zuzan was indeed Hanafi, so the association is surely valid.

It is not without interest to note that the early-12th-century world-*qibla*-list by the scientist al-Khāzinī of Marw, with longitudes, latitudes and qiblas for 250 localities, has no values for Zusan or for Herat, but gives 46;10° for nearby Nishapur, which would be a few degrees off the *qibla* for Zusan. The anonymous world-*qibla*-list from early 15th-century Kish near Samarqand with entries for 274 localities has 51;53° for the *qibla* of Zusan, but this results from a (very rare) computational error and the value should be 50;37°.[775] I would expect that any religious architecture built

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[774] *Idem*, "Lost in translation: Gridded plans and maps along the Silk Road" (2009).

archaeologist and art historian André Godard (1881-1965), had measured the orientation as 80° to the meridian, which is most likely 260° or 10° S of W (and less likely 280° or 10° N of W).[775] She not unreasonably invokes indirectly the

during the period 1450-1850 in a large region around Zusan would be oriented in the direction of *ca*. 50° W of S.

The Grove Encyclopedia of Islamic Art and Architecture

The monumental 3-volume 2,000-page *Grove Encyclopedia of Islamic Art and Architecture*, edited by Jonathan Bloom and Sheila Blair and published in 2009 by Oxford University Press, was hailed as "the most comprehensive reference work in this complex and diverse area of art history".[776] There is, of course, and as we have already noted, not a word about the Cairo wind-catchers in the article "Wind Catchers", which is restricted to Iran. But there is also nothing on the *qibla* in the article "Mihrab". The author of the article "Mosque" was more interested in hypostyle mosques, mosques with four *īwān*s, and domed mosques, than mosques facing the Kaʿba.

One should not necessarily assume that these omissions were deliberate, and certainly not that the editors are at fault. The 1,400-year-old tradition of orienting mosques in the sacred direction is simply a topic nobody would wish to broach or, more likely, nobody knew anything much about. Rather, these omissions appear to stem from the way in which some of the individual articles were culled from an earlier work on art history (*Dictionary of Art*, 34 volumes, 1996) of which Islamic art history was just a part.

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pronouncements of the 11th-century *qāḍī* al-Bazdawī, who wrote a treatise on the various *qibla*s between due south and due east used by different interest groups in Samarqand.[775] He mentions that the Hanafis faced due west, and so Sheila assumes that the legal school tendency [775] These two *qibla*-lists are published in King, *World-Maps for finding the direction of Mecca* (1999), pp. 71-75 / 564-585 and 86 + 149-156 / 456-477.

[776] Bloom & Blair, eds., *Grove Encyclopedia of Islamic Art & Architecture* (2009).

Yehia Weziri

The Egyptian historian of architecture Yehia Weziri has published books in Arabic on astronomical features in ancient architecture and aspects of traditional Egyptian architecture.[777] In particular, he presents overviews of how a *malqaf* functions, albeit without reference to the scene in medieval Cairo. Furthermore, he presents his readers with an account of the astronomical orientation of the Kaʿba, the only one in modern Arabic that I have seen.

Robert Hoyland

Robert Hoyland is a historian of the Ancient Near East who is a former student of Patricia Crone. He apparently has no time for and no trust in Muslim authors on early Islam, preferring non-Muslim sources when these are available. The revisionists, as he and likeminded colleagues are known, feel free to comment on all aspects of early Islam even when there are no credible non-Muslim texts on those particular aspects. Hoyland has written on the early *qibla* in Egypt in his ground-breaking book *Seeing Islam as others saw it* (1997). He is not happy about what I have written on the orientation of the Kaʿba and on the *qibla* in Egypt, but, like Cook and Crone before him, and the *revisionistas* with him, he is not well informed on early *qibla* determinations. He gives the impression of believing that the 'true' *qibla* is the modern one, and I am sure he will correct me if I err on this and other points.

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777 See Wezeri, العمارة والفلك (2013), pp. 107-115, on the orientation of the Kaʿba and folk-astronomical ways of facing it. It is a pleasure to thank Prof. Wazeri for sending me pdfs of his publications that were not on his academia.edu site, and also for his corrections to an early version of **Part II** of this study.

(The orientation of the Kaʿba merits one sentence in the anonymous Wikipedia article "Kaʿba", with references to tertiary sources.)

Since Hoyland is the first scholar in 35 years to so much as comment on what I wrote, I take his comments very seriously:[778]

> "King argues that the Kaʿba itself was aligned in accordance with natural and astronomical phenomena. The early Muslims, he says, "knew that, when facing a particular wall or corner of the Kaʿba in Mecca, one was facing a particular solar or stellar rising or setting point; they assumed that, away from Mecca, if one faced in that same astronomical direction one would still be facing the same wall or corner of the Kaʿba".
>
> [Reference to "Astronomical alignments in medieval Islamic religious architecture" (1982) and "On the orientation of the Kaʿba" (1982)].
>
> "The theory is ingenious, but it presumes knowledge among the early Muslims of the medieval theory that each side of the Kaʿba was associated with a specific regions of the world. Likewise, the large amount of material in later sources describing how such natural phenomena as the winds are determined in relation to the Kaʿba derives only from a time when the Kaʿba was conceived as the centre of the world and universe.
>
> [Reference to Heinen, *Islamic Cosmology* (1982).]
>
> "King also takes no account of the frequency with which the Kaʿba was demolished and rebuilt in earlier times and the stone itself removed, and he makes many conjectures, such as that "the mosque of ʿAmr in Fustat, the first mosque built in Egypt, is also aligned to face the winter sunrise".
>
> [Reference to "Astronomy of the Mamluks – A brief overview" (1984), p. 79. This careless remark of mine relates to the second mosque, not the first, whose orientation toward the east is adequately documented in "Architecture and astronomy" (1984).].
>
> "In general, his theories are insightful and revealing of medieval times, but do not stand up when retrojected to the first two centuries of Islam."

Now for the time when the Kaʿba was considered "as the centre of the world and universe", Hoyland cites the edition and translation by the

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778 Hoyland, *Seeing Islam as others saw it* (1997), pp. 572-573.

German orientalist Anton Heinen (1939-1998) of the book on sacred cosmology by the 15th-century Egyptian polymath al-Suyūṭī,[779] which I too had cited. But in a review of Heinen's book I pointed to the fact that although al-Suyūṭī is so late, this work of his is important not least because it is based almost entirely on sources supposedly from the 7th to the 10th century.[780] So is Hoyland talking about the 15th or the 7th-10th centuries?

In my 1984 study of orientations in Cairo, as in the present monograph, I did indeed quote a 16th-century astronomer (al-Ḥalabī) who wrote that the Mosque of ʿAmr "was aligned toward winter solstice", but I then discussed all of the earlier sources known to me at that time which stated that **the first Mosque of ʿAmr was first built to face due east**.

The Kaʿba is situated in a *wādī* which used to flood regularly and the edifice has indeed needed to be rebuilt several times. It is well known that the Black Stone was occasionally removed. To the criticism that the present orientation of the Kaʿba – which Hoyland does not describe – is not its original orientation I would respond simply that, in my opinion, the shape and orientation of the Kaʿba were almost as sacred as the Kaʿba itself. (And one should not forget the low semi-circular wall spanning the north-west wall, which is an integral part of the edifice; this wall, called الحجر, *al-ḥijr*, has been thought by some, notably Günther Lüling (1928-2014), to be the remains of a pre-Islamic church.) No medieval text is known to me in which it is stated that the orientation of the Kaʿba was ever changed. I would take these remarks of Hoyland more seriously if he were

779 Heinen, *Islamic Cosmology: A Study of as-Suyūtī's al-Hay'a al-saniya fi-l-hay'a al-sunniyya* (1982).

780 My review of Heinen 1982 in *Journal of the American Oriental Society* 109 (1989): 124-127, is available at www.academia.edu/34693225/, and stresses the historical importance of the materials presented and interpreted by my late friend Anton Heinen. The review dates from a time before the role of folk astronomy in the organization of Muslim ritual had been documented.

better informed about the ways in which the orientation of the Kaʿba was changed whenever it was rebuilt.

It is significant, I think, that the **13th-century** Yemeni astronomer Muḥammad ibn Abī Bakr al-Fārisī, who wrote the most detailed known account of the orientation of the Kaʿba (**Ch. 14**), probably relying on an earlier source (he was based in Aden and is not known to have visited Mecca), and the **20th-century** British/American archaeo-astronomer Gerald Hawkins (1928-2003), who first investigated the orientation of the Kaʿba using modern means, both reached the same conclusion about the orientation.[781] For Hoyland, this would mean only that the orientation of the Kaʿba would have been changed between the 7th and the 13th century; we should perhaps look for some statement about the orientation of the Kaʿba being changed during that time, written by some Armenian bishop. I jest, of course.

Just one citation comes to mind: the famous historian al-Ṭabarī (839–923) records that when "anti-Caliph" Ibn al-Zubayr attacked Mecca and damaged the Kaʿba in 672,[782] he had the edifice rebuilt "**on its**

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[781] King & Hawkins, "The orientation of the Kaʿba" (1982). The Wikipedia article "Kaʿba" quotes these results from secondary archaeo-astronomical sources.

The architectural archaeologist Reza Assasi of McGill University in Montreal is one of the few authors to have mentioned the orientation of the Kaʿba recently. In his short article "Kaʿba – a house built under the Sun" (n.d.), p. 4, he writes:

> "(Hawkins & King) conclude that their findings are not accurate for the purpose of astronomical analysis to find alignments to specific orientations such as solstitial and equinoctial points of the local horizon."

This unfortunately misinterprets our results, which were that the Canopic and solstitial alignments were confirmed, but that no lunar limit was discernible for the minor axis. Meanwhile, most other authors continue to repeat the myth that the base is square and the corners face the cardinal directions.

[782] Article "ʿʿAbdallāh ibn al-Zubayr" in *Enc. Islam*, 2nd edn., by H. A. R. Gibb.

foundation". This rebuilding of the Kaʿba is related by the great historian al-Ṭabarī),[783] and is here paraphrased:

> "A statement attributed to the Prophet Muḥammad, who had said it to his wife Āʿisha: "If it were not that your people had only recently been in a state of unbelief, I would restore the Kaʿba on the foundations of Abraham and I would add to the Kaʿba part of (the low semicircular wall called) the *ḥijr*." A certain person heard Ibn al-Zubayr, on the day when he was defeated, repeat this story, which he had originally heard from his own mother. In any case, Ibn al-Zubayr gave the order for the Kaʿba to be restored. It was excavated and rocks as big as a camel were found. The workers moved one of the boulders and a bright light flashed out. **They reestablished it on its foundation** and Ibn al-Zubayr rebuilt it with two doors, one for entering and the other one blocked."

Important for our purposes is the fact that in this very brief report of an actual rebuilding of the Kaʿba, there is no mention of the orientation of the edifice being changed.

In my 1984 study (as here above) I did indeed cite texts in which it was stated that the Mosque of ʿAmr was first oriented toward the east. Even after reconsideration of the sources, and taking into account Hoyland's useful remarks, **I am still completely at a loss to explain how scholars in medieval Cairo could equate the *qiblat al-ṣaḥāba* with winter sunrise, when it was the second mosque which was oriented in that direction, some 70 years after the first mosque had been erected facing due east**.

In any case, Hoyland cites the very same sources that I cited in 1984 – al-Bazdawī (the 11th-century legal scholar of Samarqand), and the orientalists Barthold, Heinen, and Lorch – to support his argumentation.

783 al-Ṭabarī, *History*, XX (transl. G. R. Hawting), p. 176, with reference to other versions of the Prophetic *ḥadīth*.

But he does not mention Arabian folk astronomy, and he seems not to know about Islamic sacred geography, first surveyed in my 1987 article "Makka as the centre of the world" in the 2nd edition of the *Encyclopedia of Islam*, but not cited by him. Hoyland's early non-Muslim sources and his modern readers knew / know nothing about this colourful tradition which began in the time of the Prophet Muḥammad with a Kaʿba whose corners roughly faced the four cardinal directions, and which had different manifestations in different regions of the Muslim world over the centuries, indeed, for well over a millennium.[784] As a matter of interest, just when did the corners of the Kaʿba get the names they have had throughout recorded history?[785]

Robert Hoyland has also published his insightful book *Arabia and the Arabs – from the Bronze Age to the coming of Islam* (2001), a topic for which there are many more original sources available than the well-known Arabic ones, these being for Hoyland untrustworthy anyway. The pagan shrine of the Arabs at Mecca gets but a single mention, in the form of a statement from an Arab historian about its first recorded manifestation as an enclosure, surrounded by a wall so low that a goat could jump over it. بس كدا . That's all! One of the first articles I read in the 1970s as I was

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784 I have to thank the *revisionistas* for pushing me to publish information on materials which I collected in the 1970s and '80. Ever since Dan Gibson was confronted with the news that the early Muslims used astronomical alignments for the *qibla* (which demolished his Petra theory), he has been repeating that he and his 'team of scholars' have not found any texts which support this claim of mine. In 2019 I put up on my website "Finding the *qibla* by the sun and stars – Islamic sacred geography", identifying some 50 medieval sources, and there are doubtless many more. The article "Makka as centre of the world" in the *Encyclopaedia of Islam* provided an introduction to the topic.

785 See Simon O'Meara, "The Kaʿba of New York" (2018), pp. 150-151, on whether the regions of the earth were named after the four corners of the Kaʿba or the corners were named after the regions.

getting into Islamic Studies was K. A. C. Creswell's very nice article on the rebuilding of the Kaʿba in the year 608.[786]

A book on Arabia and the Arabs before Islam which barely mentions Mecca and the Kaʿba is just what those cranks need who claim that Islam did not start in Mecca and Medina at all but in Petra, although for that claim there are neither Islamic nor non-Islamic sources (but there is, apparently, plenty of funding). The Kaʿba was there, in Mecca, not in Petra (!), and we can retroject long before the advent of Islam.

Krisztina Szilágyi

In a recent article on the cardinal directions in a new encyclopedia of the Bible, the Cambridge University scholar of Near Eastern history, Krisztina Szilágyi, has ventured into the subject of the early *qibla*.[787] Whilst not specifically relevant to the situation in Egypt, her discussion is partly misguided:

> "Cardinal directions lack religious significance for Muslims [*sic*]. Their sacred direction (*qibla*) is oriented towards a place: the Kaʿba in Mecca. In this they differ from Oriental Christians and Zoroastrians, whose sacred directions are cardinal directions (east and south, respectively), and resemble Jews and Samaritans, whose worship is oriented towards sacred locations. Islamic law enjoins Muslims to perform certain activities, most conspicuously prayer and burial, facing the *qibla*. ... In order to help Muslims find the correct [?] direction, mosques are oriented towards it with a prayer niche (*miḥrāb*) inserted into the *qibla* wall.
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> **"However important the sacred direction was, the orientation of the**

786 Creswell, "The Kaʿba in A.D. 608" (1951). See also G. King, "The paintings of the pre-Islamic Kaʿba" (2004). An important study of the Kaʿba is Rubin, "The Kaʿba: Aspects of its ritual functions" (1986).

787 Krisztina Szilágyi, "Cardinal directions (Islam)", in *Encyclopedia of the Bible and its Reception*, vol. 6 (date?), pp. 862-863.

earliest mosques (according to archaeological and literary sources) often deviated from it [!!] and was corrected in a later period [rarely]. Scholars have advanced various explanations to make sense of this phenomenon, some citing the difficulty of finding the exact direction, others pointing to Muslim traditions that allow facing the general direction of the Kaʿba rather than its precise location, and still others positing that the change in the orientation of these mosques was part of the formation of Islam in its first century when other religious practices were also modified. Finally, David King has suggested **that the mosques that seemingly face the wrong direction [!!]** were in fact aligned with a wall of the Kaʿba, and so the praying faithful turned in the same direction as the wall. In the current state of research [whose?] it seems that the first two explanations, the simplest ones, sufficiently clarify the early deviations from the *qibla*. (Hoyland: 560-73; Crone/Cook: 21-24; Bashear 1991; Rius 2000; King 1999; 2004; 2005)."

The cardinal directions are important in Islam because the *sanctum sanctorum* is thought by many to be aligned with the cardinal directions. I never wrote that mosques face "the wrong direction", not even "seemingly". I did write that early Muslims could have found the *qibla* by facing in the same direction as the appropriate wall or corner of the Kaʿba. I did not make this up – it is mentioned in numerous medieval sources and documented in the article "Makka as the centre of the world" in the *Encyclopedia of Islam* and elsewhere. The simplest techniques for finding the *qibla* involved standing in a certain way relative to the Pole Star; behind that was the idea of facing the appropriate part of the Kaʿba.

The main problem with Krisztina Szilágyi's discussion is that she seems to think the only true *qibla* is the modern one. In this she is not alone, for many historians of early Islam and many historians of Islamic architecture, think the same. And most Muslims will tell you the same thing. The historical situation is more complicated, for medieval Islamic civilization was rich and varied, and the modern *qibla* is only the *qibla* for modern times.

Doris Behrens-Abouseif

The major work now available on medieval Cairo architecture is Doris Behrens-Abouseif's splendid book *Cairo of the Mamluks: A history of the architecture and its culture* (2007).[788] The book has many merits, but the author has no serious discussion of the *qibla*, which is perhaps just as well. The author is perhaps the first to attempt to show on a mosque plan what the *qibla* direction was at the time when the mosque was built, but there is also no explanation of any of this. In all of the numerous plans in this book the *qibla* is shown on a compass diagram showing true north-south, but it is alas the false direction: **37° E of S** instead of the most popular Mamluk value **37° S of E**, as computed by Ibn Yūnus over a thousand years ago.[789]

There are two mentions of mosque orientations.[790] First, a discussion of a mosque and a Sufi convent with *miḥrāb*s inclined to the main axis of the building, labelled as "oddities". Alas, no plans are shown and the directions are not stated. Secondly, in a discussion of the Mosque, built in 1368/69, of Khawand Baraka, mother of Sultan Shaʿbān. There is an incorrect citation of a pronouncement of Christel Kessler, who alas was not sure what was "Mecca-oriented" and what was not.

Nicholas Warner

Nicholas Warner, in his 2005 book *The Monuments of historic Cairo*, already mentioned, includes a brief remark on orientations restricted to citing various publications of Christel Kessler, which "highlighted complexities in the orientation of religious buildings, particularly Mamluk

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788 Behrens-Abouseif, *Cairo of the Mamluks: A history of the architecture and its culture* (2007), *passim*.

789 A 15th-century Egyptian copyist made a similar mistake, but more serious: see King, "Mathematical geography from 15th-century Egypt" (2008), p. 17. He gave the *qibla* of Cairo as 13° and 37° S of E, where '13' is a scribal error for '53' in the *abjad* notation.

790 Behrens-Abouseif, *Cairo of the Mamluks* (2007), pp. 99-100 & 220-221.

funerary architecture".[791] On some of his plans we find directional indicators marked with "magnetic north" and "qibla", the latter at "135° east of magnetic north (the correct bearing for Cairo)". However, the modern *qibla* for Cairo is 130.5° from magnetic north because the magnetic declination is currently about 4.5° E (of true north) there. Wisely, our author admits:[792]

> "No attempt has been made to differentiate [?] the numerous [?] other *qibla* directions used in the city during historical periods."

The modern *qibla* is indeed considered the "correct bearing" nowadays. It was, however, not the *qibla* that was used in medieval Cairo and it is actually irrelevant to any discussion of medieval architecture. Alas, Warner's numerous plans are fitted with a directional indicator showing magnetic north (which we don't need anymore) and a dubious "qibla" of **37° E of S** (in error for **37° S of E**, but this is only one of several *qibla*s accepted in medieval Cairo).

Nasser Rabbat

The fact that different *qibla*s were accepted in different parts of the city of Cairo is mentioned in passing by Nasser Rabbat in his *Staging the City: Or how Mamluk architecture coopted the streets of Cairo* (2014).[793] He is thus able to remark on the different orientations inside and outside of some of the Mamluk mosques, but nowhere are there clear statements of the orientations or clear statements about the medieval *qibla*(s). Some of the plans have no directional indicators at all. The *qibla* is marked on some of the plans, but which *qibla* is it? There is no clear statement about the

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791 Warner, *Monuments of historic Cairo* (2005), p. 42 and n. 83.

792 *Ibid*., p. 84 and the various plans.

793 Rabbat, *Staging the City: Or how Mamluk architecture coopted the streets of Cairo* (2014), esp. p. 22.

orientation of the Fatimid city or the *Darb al-Aḥmar*, which would have helped to set the scene.

A volume of reprints of studies by Nasser Rabbat well reveals the author's understanding of the importance of Egyptian and Syrian architecture. However, there is not a single informative reference to either the *bādahanj* or the *qibla*.[794] Of the Azhar Mosque he comments:

> "The old *haram* of the mosque is oriented at 40 degrees south-east, which is slightly off the *qibla* (fig. 26)."

His fig. 26 has no north-pointer. But the *qibla* to which he is referring is the modern *qibla*. The Mosque is actually oriented at 37° S of E, which is the *qibla* calculated by Ibn Yūnus. I doubt that the orientation of the Mosque is "slightly off" this value. Somebody should check the orientation.

Kathryn Moench

Kathryn Anne Jasmin Moench is the author of a 2015 Master's thesis in Advanced Studies in Architecture at the University of British Columbia in Vancouver. Its imposing title was "Adjacency of the Other: An examination of the impact of alterity on the production of built form during the Mamlūk Sultanate".[795] The purpose of the study was "to understand the spatial consequences of Mamluk social identity and rule on urban architectural form" in Cairo during the Mamluk period, with "particular examination ... made of the quality of Otherness inherent to the Mamluk identity." The thesis is very different from most other writings in Mamluk studies, being composed in new-speak. I make no claim to be able understand it, and fortunately, for our present purposes, there is no need.

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794 Rabbat, *Mamluk history through architecture* (2010).

795 Moench, "Adjacency of the Other ... " (2015), esp. p. 101.

The term *qibla* is mentioned once in the main text of the thesis, namely, in the following very fine section:

> "The responsiveness of Mamlūk buildings is evident in their effort to integrate themselves into awkward sites within al-Qāhira urban fabric; overall they do not assert themselves as separate entities but rather insinuate themselves into the street-scape. The buildings' exteriors are oriented to the urban environs while the interiors derive orientation from religious spatial doctrine and are aligned—approximately rectilinearly—toward Mecca. The oddly shaped space between the street lines and the internal *qibla* walls – the wall whose orientation is fixed towards the Kaʿba in Mecca – become points of mediation between the external urbanity and the architecture."

There is a lot more that can be said about "built form" in Mamluk Cairo, but first one has to understand the role of the *qibla* in Islamic architecture.

Abbas M. Hassan & Hyowon Lee & Uoosang Yoo

In 2015 an Egyptian Abbas M. Hassan and two S. Korean environmentalist engineers, Hyowon Lee and Uoosang Yoo, published a curious paper aiming at being a comparative study of medieval Cairo and modern "clean energy" Masdar City in the Gulf.[796] They are typical of a new genre of young scholars who ignore or deprecate earlier orientalist studies but have nothing to offer themselves. They like to start by demolishing everything that (they think that) earlier orientalist authors have written. Barely anyone cited by our three authors escapes their wrath, for they fall for all the bad things that orientalists are supposed to be. There is inevitably no mention of and no understanding of the very clear distinction between the "orientalists" who supposedly denigrated medieval Islamic civilization and the "orientalists" who documented it or

[796] Hassan & Hyowon Lee & Uoosang Yoo, "From medieval Cairo to modern Masdar City: Lessons learned through a comparative study" (2015).

published it. For our authors, orientalists are defined mainly in terms of colonialist interests.

The scholar who gets the most blame from our young urban planners is, of course, Archibald C. Creswell (1879-1974), fondly called "Archie" by his friends, who, at least in the opinion of the present writer, did more for the architectural heritage of medieval Cairo in the Anglophone world than all others put together. Our authors maintain:

> "Orientalists' allegations have contributed to a cheapened image of the conventional Arab city. Arab planners ignored their heritage, particularly in urban planning and architecture. Creswell misunderstood Arab society and urbanism. Most Arab planners dismissed Arab-Islamic architectural heritage and adopted Western planning theories that were applied to a very different social structure, in comparison to the habitat for which they were originally designed. The results were disappointing on all levels, notably that of urbanism."

Oy veh! The only publication of Creswell's in our author's bibliography was a 7-page specialist article for art connoisseurs published in 1953.[797] Entitled "Problems in Islamic architecture", it dealt scientifically and in plain English with various historical questions of some interest (only) to architecture historians. Creswell's article was <u>not</u> entitled "The problem with Islamic architecture". To claim that the author of those splendid volumes *Early Muslim architecture* and *Muslim architecture of Egypt* "misunderstood Arab society and urbanism" on the basis of that single specialist article (or any of his major publications) is outrageous. For Creswell the "problem" with Islamic architecture was that it needed to be documented scientifically, to which endeavour he devoted his life.

Now the word *qibla* does not occur at all in the text of our three authors. This could be taken as revealing how much they are at risk of misunderstanding Islamic city-planning and architecture, medieval and

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[797] Creswell, "Problems in Islamic architecture", *The Art Bulletin* 35 (1953): 1-7, available at https://vdocuments.mx/problems-in-islamic-architecture.html.

modern. The authors ignore the *qibla* and orientations in Cairo simply because these are not mentioned in any of the literature they cite. They do venture to mention out of the blue that:

> "the streets in medieval Cairo might have been angled in the direction of the Kaʿba in Mecca."

As far as I know, nobody else has ever made such a claim since I discovered the relationship between the layout of medieval Cairo and the *qibla* in the early 1970s, thanks to medieval Egyptian astronomical texts dealing with wind-catchers. The source given by the authors for this tidbit of information is invented. They attribute it to the American geographer of the Near East, Michael Bonine (1942-2011), but Bonine did not mention Cairo in his article, which is his ground-breaking 1979 study of the morphogenesis of cities in Iran.[798] Our authors obviously had no inkling what the claim which they mis-cited meant. If true, and had they understood it, it would have been worth a book, and no less a rewriting of much of the history of Islamic architecture. In its essence, the statement is true. We shall soon see how.

The three authors also state that Michael Bonine had claimed that Islam was "a religion of mess", citing his same 1979 study, where this remark is, not unexpectedly, and needless to say, not to be found. What Bonine did write in his summary and did demonstrate in his article was quite the opposite of what the authors claimed:[799]

> "Traditional Iranian cities have an orthogonal network of streets which does not conform to the maze of irregular, twisting lanes postulated for the ideal Islamic city."

It was not Bonine who first postulated the maze of irregular, twisting lanes for the "ideal" Islamic city. The most recent scholarship on the concept of

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798 Bonine, "The Morphogenesis of Iranian cities" (1979), available at www.researchgate.net/publication/227632830.

799 *Ibid*., p. 208.

“the Islamic city” is not cited by our authors.[800] Michael Bonine and I discussed this and much more – *qibla*s and orientations from al-Andalus to India and Central Asia – whenever we met at conferences in the U.S. in the 1970s and ’80s.

Happily, I was not standing in the line of fire of the youthful resentment launched by the urban-planning-historian triumvirate toward our illustrious orientalist predecessors. This was not as a result of any merit on my part but, rather, simply because the three authors were totally innocent of the existence of any of the substantial literature available on the orientation of Islamic architecture, let alone my own contributions to the wind-catchers and mosque orientations and city-layout in medieval Cairo.

In brief, I feel rather sorry for our three authors, and not only for them, not least because they do not seem to know much about medieval Cairo. The “mess” is in their citations. And yes, the historical city was indeed partly devastated in an attempt by European colonialists to modernize Cairo and the onslaught continues. But Abu Dhabi has also been built up mainly by Western architects with, dare I say, little sincere interest in respecting any traditional Arab architecture. Masdar City may be an exception, but I doubt it.

Ahmed Ali Gaber and Ismail Ahmed Amer

An interesting paper on Mamluk madrasa design and construction appeared in 2018. Its authors were Ahmed Ali Gaber and Ismail Ahmed Amer of the Architecture Department of Minya University. Entitled “A generative technique for Mamluk madrasa buildings design”, their study

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800 Useful introductions to the literature are in Janet Abu Lughod, “The Islamic City – Historic myth, Islamic essence, and contemporary relevance” (1987), and André Raymond, “Islamic city, Arab city: Orientalist myths and recent views” (1994).

breaks new ground.[801] The details need not concern us here, save to note that they give due importance to *qibla*-orientations, which distinguishes their work from that of many of their predecessors. (They are not aware of the writings of Kessler or King.) They do not actually define the Mamluk *qibla*, but they not unreasonably take as "*qibla*", the orientation of the *miḥrāb*s in the madrasas they investigate, which is, of course, the *qibla* of Ibn Yūnus. I hope that their paper will provoke some discussion in the field of the history of Cairene architecture.

Bernard O'Kane

A new book by the Cairo-based American specialist of Islamic architecture, Bernard O'Kane, is entitled *The Mosques of Egypt*.[802] It is beautifully and copiously illustrated; indeed, this is a superb photo-album of mosques all over Egypt. Any *bādahanj*es previously documented in any of the mosques treated in the book have disappeared. معليش . But there is no clear statement at the beginning of the book under the rubric "What is a Mosque?". A mosque is, in fact, sacred space defined by a sacred direction, not just domes and minarets and those things on which people like to focus.

There are dozens of photos of *miḥrāb*s, but no clear statement what a *miḥrāb* is and what we know about mosque orientations. Instead, the author jumps into a discussion of a multiplicity of *miḥrāb*s in Fatimid

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801 Ahmed Ali Gaber & Ismail Ahmed Amer, "A generative technique for Mamluk Madrasa buildings design" (2018).

The source of the authors' information on the role of astronomers in mosque life in Mamluk times is dubious. More reliable information is to be found in King, "On the role of the muezzin and the muwaqqit in medieval Islamic society" (1996/2004), and Brentjes, "Shams al-Dīn al-Sakhāwī on muwaqqits, mu'adhdhins, and the teachers of various astronomical disciplines in Mamluk cities in the 15th Century" (2008).

802 O'Kane, *The Mosques of Egypt* (2016).

mausolea and a quadruple *miḥrāb* in the mausoleum of the Imām al-Shāfiʿī. He does not mention any of the mosque-orientations documented by al-Maqrīzī, and his numerous plans all indicate a "Qibla" at **37° E of S**, a misrepresentation of the most common Mamluk *qibla*, which was **37° S of E**. Any conclusions about mosque orientations drawn from such plans will inevitably be invalid. So, for example, the funerary complex of Khayrbak (1502-1521) does not have "an incorrect qibla orientation", as claimed by O'Kane. The northern *miḥrāb* faces a direction between due east and winter sunrise, both centuries-old *qibla* directions in Cairo-Fustat. The southern one has an orientation that is more or less south-east, the same as that of the Mosque of Ibn Ṭūlūn (876-879), which *qibla*-direction is mentioned by al-Maqrīzī. This the same as the orientation of the funerary mosque of Maḥmūd Pāshā (1568) and the Mosque of Sinān Pāshā (1571). What did the builders have in mind? There is work to be done.

Amenah Abdulkarim

In her exceptional 2017 doctoral thesis on the role of the *muhandis* or master builder / engineer / architect in Mamluk society, the Mamlukologist at Kuwait University, Amenah Abdulkarim, cites the studies by Christel Kessler as far as architectural orientations are concerned. Thanks to our mutual discussions in Cairo in the 1970s, Christel in her later work did start to distinguish between the "*qibla* of the *ṣaḥāba*" and the "*qibla* of the astronomers".[803] These terms seldom appear in the later modern literature, and I was pleased to find them at last in Amenah Abdulkarim's thesis. There is no exploitation of the fact that the

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803 Abdulkarim, *Building Craftsmen in Mamluk Society* (2017), p. 60 and the accompanying figures/plans from Kessler's articles – see already nn. 715, 716 and 719 above.

Fatimid city was (conveniently / deliberately / happily) oriented with its minor axis facing the "*qibla* of the *ṣaḥāba*".[804]

Fabrizio Anticoli

A brand new study by the Italian independent scholar Fabrizio Anticoli discusses early mosque orientations in seven pages with greater insight than any historian of Islamic architecture has done.[805] Whilst his interest was primarily in the origin of the mosque, the introduction of the *miḥrāb* and the change of the *qibla*, Anticoli discusses orientations in general and specific individual mosques across the Muslim world in particular, including the Mosque of ʿAmr. One of his pronouncements is based on a misunderstanding, namely:

> "The studies carried out by D. A. King on folk astronomy and Islamic sacred geography, however, made it clear that the first mosques were not oriented according to a specific direction, but rather on the observation of stars."

Not so. My studies showed that the first mosques were very definitely oriented toward a specific direction, namely, the direction of the Kaʿba. This was achieved by using the same astronomical orientations as are found in the Kaʿba itself.

Perhaps a study such as that of Anticoli, the new book of Simon O'Meara, and the present monograph will arouse some serious interest in orientations in Islamic religious architecture and urban planning.

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804 This in spite of the remark: "King emphasises that *bādahanj*s were not only set parallel to the axis of Old (Fatimid) Cairo for aesthetic purposes, but also for astronomical and geographical reasons (Figure 1.11)." For "geographical" read "folk meteorological".

805 Anticoli, "Some remarks on the appearance of the mosque: the introduction of the niche-*miḥrāb* and the change of the *qibla*" (2020).

Ghadeer Dardier Afify Khalifa

> "The objectives of this study will be revealed through discussion, investigation, analysis that can be detected through detailed interrogation of the objects, elements and structure of the content of this study, particularly as a basis for explaining the content and significance through the discussion and interpretation. All of this will be clear through the methodology, structure and content of this study." From author's introduction.

A few days before putting this monograph online I received a notice about a brand new paper by Ghadeer Dardier Afify Khalifa, Assistant Professor of Islamic Archaeology at Fayoum University. Its subject was intriguing and enticing: the influence of astronomical phenomena on Islamic architecture in Cairo.[806] The author has previously published on stalactites in Cairene architectural decoration, and historical pen boxes and lanterns.

Khalifa's article in the *Journal of Historical Archaeology & Anthropological Sciences*, which was clearly not peer-reviewed, confuses the use of astronomical alignments (folk astronomy) with the history of Islamic astronomy in general. Thus the first half of her paper deals with Muslim astronomers and their achievements. This is a topic that Khalifa does not master and which is in any case not relevant to astronomical orientations in Cairo as she later presents them. She insists on mentioning al-Khwārizmī several times as though he were the greatest astronomer of all time. The footnotes are filled with lengthy, disordered lists of dozens of Western publications, taken wholesale from some other source, many of which are in this context superfluous.[807] The Egyptian astronomer, Ibn

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806 Khalifa, "Some Remarks about the influences of astronomical phenomena on Islamic architecture – Analytical and applied study on selected religious architectural models in Cairo" (2020).

807 For example, M. Steinschneider, "Über die Mondstationen (Naxatra) und das Buch Arcadam", *Zeitschrift der Deutschen Morgenländischen Gesellschaft*, 1864, and S. Van den Bergh, "The Early History of Dark Matter", in *Publications of the Astronomical Society of the Pacific*, 1999.

Yūnus, unlike the others, who is important for Cairo orientations, gets not a single bio-bibliographical reference.

For the other half of her article, which has no relevant footnotes or references, Khalifa has simply reworked the text of the 1984 article on orientations in Cairo from the *Journal of the American Oriental Society*, using some 15 of the illustrations from this and other publications and adding her own insights. The wind-catchers themselves are nowhere mentioned. The organization of the text and of the references that were actually used, leaves much to be desired. However, Khalifa and I share the opinion that the orientations of religious architecture in medieval Cairo are worthy of a wider audience than the few souls who ever read my 1984 paper properly.

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Some general remarks: Many plans of medieval religious architecture that appear even nowadays are without directional indicators; those which do have them sometimes confuse magnetic with true north. Even when discussing the orientation of particular complexes our colleagues will prefer to state that "this mosque is 30° off the true *qibla*" rather than state what they think the orientation actually is, and – careful now! – what they think "the true *qibla*" is. (It is not the modern *qibla*.)

The extent to which the subject of the orientations of Cairo architecture is still in its infancy with severe teething problems is revealed by the fact that in the major modern reference work on Mamluk Egyptian architecture, a false *qibla* is shown on all of numerous plans. Yet more recently the *qibla* in medieval Cairo has been redefined as "the direction of the *qibla* (southeast)",[808] but the *qibla* in medieval Cairo was not toward southeast. The modern *qibla* for Cairo is 46° S of E, but that is irrelevant for the investigation of historical architecture since it is based on modern geographical coordinates. I cannot stress enough that comparing the

808 O'Kane, *Creswell photographs re-examined* (2009), glossary *sub qibla*.

orientations of historical architecture with modern *qibla* directions can easily lead to ridiculous and perverse conclusions.

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Not one of the colleagues mentioned above has used the materials presented by al-Maqrīzī, which we now know were taken from his predecessor al-Dimyāṭī anyway.

One could draw a (very) silly parallel about people attempting to write the history of medieval England without knowing about the *Magna Carta*, which nobody knows was based on the *Mini Carta* anyway.

There is indeed work to be done.

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We now digress to discuss a topic that has at first sight nothing to do with *qibla*s and orientations in Cairo, but which on some reflection, is indeed relevant.

More on the Canal between the Nile and the Red Sea

Few people realize the importance of the Canal that once joined the Nile to the Red Sea. It has been known to scholars for only about 200 years. It is first specifically mentioned in the *Description de l'Égypte ca*. 1800, then by a series of modern European scholars, travellers and explorers who reported the existences of long expanses of ancient canal banks extending roughly west-east along the 50-km-long Wādī Ṭumīlāt to the edge of the Isthmus of Suez, and from there south to Suez and the Red Sea. Most of these have disappeared because of the incursion of sand or through agricultural development.

The reason the Canal is rectilinear (straight) for a good stretch around where the Fatimid city was later built is that it follows the eastern edge of the Nile Delta. I shall not discuss the geological considerations which make this possible.

Other authors could have been mentioned here, such as Alfred J. Butler and his *The Arab conquest of Egypt and the last thirty years of the Roman dominion* (1902), but I shall concentrate on some more recent research.

The situation is complicated by the facts that both Ancient Egyptians and Persians laid claim to building the Canal; that the location of the mouth of the Canal was changed already in Antiquity; that the Canal through the 'new' Fortress of Babylon changed direction slightly but significantly outside the Fortress; that successive dynasties had regularly to unblock the Canal from silt; that the interior of the Fortress no longer resembled what it looked like originally; that the monument is primarily part of a Coptic region; and that the former existence of the Canal is now known mainly only to historians.[809]

(It may be of interest to nobody that this author spent much of his early youth on an out-of-use offshoot of the Grand Union Canal in Buckinghamshire, cycling along picturesque towpaths, observing wildlife and collecting for tadpoles. So a canal means something special to him.)

Carol Redmount

Carol Redmount is an American archaeologist of the Near East whose 1989 doctoral dissertation was a study of the section of the Red Sea Canal in the *Wadi Ṭumilat*. I have consulted a 1995 shorter account of the "Canal of the Pharoahs".[810] The author surveys the inscriptions that mention the canal, the earliest dating from the first era of Persian control, the latest from Islamic times. Redmount's work relied initially on the French and German studies in which the inscriptions were first published and supplemented this with ethnographic testimony and archaeological evidence. The author shows that the information provided in these texts is hopelessly contradictory: some say Necho began the Canal and Darius finished it; some say Necho began it, Darius worked on it, and Ptolemy

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809 It is also of interest to engineers managing waste water disposal in Cairo: see *Greater Cairo Wastewater Project*, *Proceedings of the Institution of Civil Engineers*, Special Issue, 1993.

810 Carol A. Redmount, "The Wadi Tumilat and the "Canal of the Pharaohs" " (1995).

finished it; Aristotle says it was attempted by both Sesostris and Darius; Pliny implies the Canal was not finished in his time.

John Cooper

> "Saith Darius the King: I am a Persian, from Persia I seized Egypt. I gave order to dig this canal from a river by the name of Nile which flows in Egypt, to the sea which goes from Persia. Afterward this canal was dug thus as I had ordered, and ships went from Egypt through this canal to Persia." John Cooper, "Egypt's Nile-Red Sea canals" (2009), p. 197. (For me, this conjures up an image of Darius with a baseball-cap bearing a cuneiform inscription "Make Persia Great!".)

> " ... this canal was opened by Necho II (reg. 610-595 BCE) and maintained by later dynasties. The Persians of the 27th (525-404 BCE) and th 31st (343-332 BCE) Dynasties repaired and deepened the canal. During the Ptolemaic Period (304-30 BCE), the canal was maintained yearly." Margaret R. Bunson, *Encyclopedia of Ancient Egypt* (2002), p. 79. (History depends on who's writing it.)

> "Cairo is to be identified with the spirit of change; Egypt with that of stability. Cairo looks always to the outer world for her life and her inspiration, while Egypt looks solely to what her river brings." Ernest Tatham Richmond (1874-1955), a British architect who spent some time working in Egypt then Palestine, in his eloquent and moving essay on Cairo's history and significance published in 1913.[811]

The Exeter University Arabist, John P. Cooper, has a unique combination of interests and expertise: he is "a maritime archaeologist and ethnographer, with a principal research interest in maritime communities of the Arab and Islamic worlds, past and present, approached through a

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[811] See already n. 414 above.

multidisciplinary combination of material cultural study, ethnography, archaeology and text." In 2009 he published an imposing paper "Egypt's Nile-Red Sea Canals: Chronology, location, seasonality and function".[812] I draw heavily on this valuable study to present a brief account of "our" Canal.

The Nile was connected to the Red Sea by a canal in a number of historical periods – the Persian (Achaemenid), Ptolemaic, Roman and Arab-Islamic. The creation of that connection was a major work of civil engineering and inidividual human effort. However, despite its scale, the Canal remains very poorly understood.

The Persian origin of the Canal is not disputed. The rather charming message quoted above is conveyed in Persian cuneiform on one of four stelae (the one from Kaf) mentioning Darius (*reg*. 522 BCE until his death in 486). The existence of a completed Persian canal is indicated by the eye-witness account of Herodotos, who visited Egypt some time after 454 BCE. The Egyptians who inherited the Canal claimed it was an Egyptian achievement, a kind of appropriation not unknown today. It was the Romans who around 110 moved the Nile entrance to the Canal further south and who called it *Amnis Troianus*, "River of Trajan". The Fortress of Babylon with its massive walls and even more massive gates was built by the Roman Emperor Diocletian around the harbour and the canal in the year 300. On the occasion of the Muslim conquest, around 640, the commander ʿAmr ibn al-ʿĀṣ proposed reopening the Canal, writing "when we conquered Egypt that canal was cut."

The Roman-Arab Canal was 170 km long, and between 30-60 m wide. Cooper estimates some 20,000 men would have been needed to dig it in a year. Because of fluctuations in the height of the Nile, the Canal would

[812] John P. Cooper, "Egypt's Nile-Red Sea canals: chronology, location, seasonality and function" (2009).

have been functional only three months of the year and at times would have been empty.

John Cooper is also the author of a 2014 book entitled *The Medieval Nile: route, navigation, and landscape in Islamic Egypt*.[813] I have not seen this book but can understand its uniqueness and potential importance. I take the unusual step of quoting from the publisher's blurb:

> "This is a ground-breaking view of the navigational landscape of the Nile in medieval Egypt, drawing on a broad range of sources: medieval Arabic geographies; traveler accounts; archaeology; and meteorological, hydrological, and geological studies. Its first major section charts the changing geography of the Nile waterways, particularly in the Delta, from the eve of Islam to the early modern period, and logs the "rise and fall" of these waterways for natural and/or anthropogenic reasons. The book then presents a new perspective on the Nile: it draws on traveler accounts and environmental data to portray the river as a uniquely challenging and sometimes dangerous navigational environment requiring extensive local knowledge by skilled and hard-working Nile navigators. Finally, the book looks at how the main Delta and Red Sea ports of medieval Egypt fitted into the navigational landscape described: it explains how these ports were effected by changes occurring to the navigational landscape, and how they reflected the navigational conditions of the Nile and surrounding seas. The book is richly illustrated with maps and images."

As any history book should be.

Peter Sheehan

> " ... through ... the city of Babylon the River of Trajan flows." From the *Geography* of Claudius Prolemy, Alexandrian astronomer and geographer, *fl. ca*. 125, cited in Sheehan, *Babylon of Egypt* (2015),

[813] John P. Cooper, *The Medieval Nile: route, navigation, and landscape in Islamic Egypt* (2014).

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> “Any research that broadens our archaeological purview of Egypt to include the brilliance of Egyptian history in the medieval period is a welcome corrective to Egyptological obsessions and lingering and still widespread Orientalist tropes that present Egyptian civilisation as having ended with the death of Cleopatra. In contrast, Sheehan’s multi-periodic treatment of Babylon presents the Egyptian past as an accretion of human action and occupation in which each layer of human activity is contingent on and shaped by that which went before.” John P. Cooper, review of Sheehan, *Babylon of Egypt* (2015), p. 473.

Peter Sheehan is a British archaeologist of the Near East who is now Head of Historic Buildings and Landscapes at the Department of Culture and Tourism in Abu Dhabi. During the period 1999-2005 he was based at the American Research Center in Egypt (my old haunt 25 years previously) and conducted an operation to lower the groundwater level affecting the monuments and churches of this area. This revealed a sequence of continuous occupations extending from the 6th century BCE to the present day. The monuments included the massive stone walls of the Canal linking the Nile to the Red Sea and the harbour constructed by Emperor Trajan at its entrance around the year 110. Much new light was cast on the Fortress of Babylon built by Emperor Diocletian around the harbour and the canal in the year 300.

Sheehan’s recent book *Babylon of Egypt: The Archaeology of Old Cairo and the Origins of the City*, is, I find, remarkable not only in that it delivers precisely what is promised in the title but indeed in every part and section of the table of contents. It is also eminently readable.[814] A few remarks must suffice here, and anybody who wants to know more information

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[814] Sheehan, *Babylon of Egypt: The Archaeology of Old Cairo and the Origins of the City* (2010/15).

about the reason the centre of medieval Cairo was built where it was, must read Sheehan's book.

The major axis of the Fortress at about 40° E of N through the north-east gates leads to the Via Praetoria, heading for 3 km toward Rumayla, an area below the later Citadel. This road seems to have been laid out by the Romans for troop movements. The minor axis at about 40° S of E leads through the south-east gates lead to another Roman road, which is straight for a kilometer and then veers off to the left over *al-Qarāfa al-kubrā* toward the Red Sea.

The Canal inside the Fortress is aligned toward about 40° E of N within the Fortress, but – how to explain this? – it is aligned at about 30° for most of its path further north where the Fatimid City was later built. It seems that just outside the northern gates of the Fortress, the Canal makes a 10° turn to the left, from about 40° to about 30° E of N. This kink is actually shown on Sheehan's map and is more clearly visible with a magnifying glass.[815]

Sheehan now moves away

from the Fortress of Babylon ——— ►

along the Red Sea Canal ——— ►

——— ► to the Fatimid city,

showing that the course of the second is responsible for the basic orientation of the third – **Pl. U7**. This is, of course, well-known but easily overlooked nowadays, not least because the Canal and most of the City have disappeared. This progression was possible for Sheehan only as a

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[815] Sheehan, p. xxiv. Compare maps of Old Cairo where no canal at all is shown within the Fortress, for example, Butler (1884), p. 10 and plan 1 facing p. 24; and Nicholas Warner, in Sheehan, p. 4, figs. 3-4). For more on the Roman roads see Sheehan, p. 51.

result of his having studied in detail the Fortress. However, he does not investigate the potential significance of the orientations of the Fortress, the Canal and the City or the mosques within the City. In fact, he makes no mention of orientations when it comes to the Canal and the City. In a sense, he has no need to; he can somehow take them for granted. But in his entire sections on the Mosque of ʿAmr and the Fatimid City there is no mention of the *qibla*. This will at least spare the author any controversy.

It could be argued that it is a pity that Sheehan was unaware of my 1984 paper on Cairo orientations, because there I also stated the obvious, but came to it by way of wind-catchers, orientation of the City (which is generally known to be aligned with the Canal), and the different *qibla*s accepted in Cairo and the ways in which these were handled. This was the first time that anyone since medieval times had realized that the minor axis of the City, which was toward winter sunset, was aligned, **fortuitously as it happens**, to what was called the *qiblat al-ṣaḥāba*. It took the wind-catchers to make me realize this, for it is not immediately obvious.

Neither does Sheehan does mention the substantial literature on astronomical alignments in Ancient Egyptian architecture and in Roman city planning. For his purposes he had no need to, but this is a pity because there were surely significant reasons why the major axis of the Fortress of Babylon is aligned at about 130° or 40° S of E. We are left wondering whether there is a deliberate astronomical alignment here, which is at first sight not obvious, and whether this has ever been investigated. (Most Ancient Egyptian and Nabataean sites display astronomical alignments.) Just as there is a mistrust of any historical research containing any numbers or any astronomical/astrological concepts, so, I suspect, there is a general mistrust amongst archaeologists of anyone who claims to have found astronomical alignments in historical architecture, let alone those who claim to be able to interpret such alignments.

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The reconstruction of the Fortress is clearly displayed in a highly informative slide-show prepared by Peter Sheehan and presented in the

former Roman capital of the Serbia region, 2018, at a conference (Limes XXIV) by his three colleagues from Moscow.[816]

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For anyone who doubts the importance of archaeology in general, another visual display by Sheehan and his colleague Timothy Power is recommended. It is appropriately entitled "Archaeology shapes history".[817]

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We conclude this chapter with a remarkable map of the Fortress and the Mosque of ʿAmr which, although it is / because it is about a century old, shows extraordinary insight into the orientations that concern us.

Ugo Monneret de Villard

The Italian art historian of the Mediterranean region, Silvia Armando, now of the John Cabot University in Rome, has published extensively on the prolific Italian engineer and archaeologist Ugo Monneret de Villard (b. Milan 1881, d. Rome 1954).[818] Monneret spent the period 1921-28 excavating in Egypt, and, along with many other things, he prepared in 1922 a catalogue of the Coptic Museum at the request of that community. Amongst his papers preserved at the Biblioteca di Archeologia e Storia dell'Arte in Rome, Armando has found a 'map' of the Coptic Fortress of Babylon, after the Arab conquest in 640 called *Qaṣr al-Shamʿ* (Castle of

816 Peter Sheehan and Dmitry Karelin & Tatiana Zhitpeleva & Maria Karelina, "Babylon of Egypt – The reconstruction of the Diocletianic Fortress" (2018) at www.academia.edu/37390902/. For the printed version see the bibliography.

817 See further the illustrated lecture text: Timothy Power & Sheehan, "Archaeology shapes History", at www.academia.edu/9550542/.

818 For a start see her "Ugo Monneret de Villard (1881-1954) and the establishment of Islamic Art studies in Italy" (2013).

Candles), situated some miles south of modern Cairo. This map she kindly published, in passing and without comment, in 2013.[819]

The 'map' – **Pl. U6** – merits our close attention. It shows at the top the square Mosque of ʿAmr and below, a hypothetical reconstruction of the basically rectangular plan of the Fortress. Various features of the complex and its surroundings are shown, including tribal districts (*khiṭṭa*s), markets, baths, and churches. In any case, both the significant direction of the Mosque and minor axis of the Fortress are oriented at roughly south-east, that is, they are oriented in the same direction. The Nile is shown flowing roughly north-south, and the south-west corner of what would be the rectangular plan of the Fortress is 'missing' because the complex has been adjusted to accommodate the River. The wall which runs alongside the Nile is pierced at the gate called *Bāb al-Ḥadīd*, from which a pontoon bridge leads out into the River.

Now that is just the beginning. Between the Fortress and the Mosque is a directional indicator marked "orientation according to al-Maqrīzī", suggesting that at least the Mosque was facing due east (surely not the Fortress as well). Inside the City there is another such directional indicator marked "orientation according to Ibn Duqmāq". From this one could be tempted to infer that the historian, a major source for al-Maqrīzī, advocated that the minor axis of the Fortress was east-west and the major axis north-south. I find this hard to believe that Ibn Duqmāq would have thought this was the case, for even a modern map for tourists shows that it is not – **Pl. N13a**. A third directional indicator in the lower right brings us back to 'reality', for it is marked: "orientazione reale".

Monneret de Villard deserves our appreciation for

(a) knowing that maps, even conjectural, are important;

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819 Biblioteca di Archeologia e Storia dell'Arte, Fonds Monneret, boîte 11, carton 1 c 97, published in Armando, "Ugo Monneret de Villard et la découverte de *l'Oriente* entre Croce et Strzgowski" (2013), p. 362.

(b) realizing that architectural and urban orientations are important;

(c) knowing that historical documents sometimes contain relevant information on architectural orientations;

(d) recognizing that rebuilding has not always preserved the original orientation (indeed, the edifice may have been rebuilt to re-orient it); and

(e) understanding and accepting that the historical texts sometimes contain contradictory reports about orientations.

Silvia Armando also merits our gratitude for making this map available.

What would be an even more remarkable discovery would be a comparable early-20th-century map revealing the alignments of three regional features – the major axis of the Coptic/Byzantine Fortress, the *qibla*-wall of the second Mosque of ʿAmr, and the major axis of the Fatimid City – in addition to the Nile and the Red Sea Canal. Had Monneret circulated such a map, generations of scholars after him might have been able to see that these three were all facing roughly parallel to each other (and parallel to the Canal at the place where the Fatimid City was built). To put it another way, the Mosque was aligned in roughly the same direction as the minor axis of the Fortress, and the rectangular City was aligned with its major axis parallel to the Canal and its minor axis in the direction that was known as the *qiblat al-ṣaḥāba*. Nothing has changed, but people have forgotten.

The article "Qibla" on Wikipedia

The article "Qibla" on Wikipedia in 1999 was somewhat pathetic, especially with regard to the way Muslim scientists calculated the *qibla*. There was also no mention of sacred geography and mosque orientations. Now, in 2020, out of the blue, a well-informed anonymous editor at Wikipedia has added some relevant aspects, and the article now provides a satisfactory introduction to this fascinating – nay, exciting – aspect of Islamic civilization, unique amongst all religious traditions and taken seriously by all Muslims to this day.

17 — An astronomical table for orienting a wind-catcher

> “ ... ... it is amusing to note that the well-equipped city (of Byzantium) also boasted of ‘astronomers’ to calculate the movements of wind and water.” John Teall, “Byzantine urbanism in military handbooks” (1977), p. 204.

> **“I see that the love of air has turned (the *bādahanj*) away from the *qibla* of Islam.”** The Egyptian poet Burhān al-Dīn al-Qīrāṭī (*fl. ca*. 1350) confirms that the wind-catchers were turned away from, that is, they were perpendicular to, the *qibla* of the Companions of the Prophet, namely, winter sunrise. Quoted from Franz Rosenthal, “Poetry & architecture” (2007), pp. 13 & 16.

Part of a substantial set of tables for astronomical timekeeping

The corpus of some 200 pages of astronomical tables for timekeeping by the sun and for regulating the times of prayer for the latitude of Cairo is available in about 30 manuscripts preserved in Cairo (Egyptian National Library & Azhar), Berlin, Gotha, Paris, Dublin, El Escorial, Istanbul (Süleymaniye & Nuruosmaniye), and Princeton. It was the mainstay of the *muwaqqit*s, the astronomers associated with the major mosques and madrasas in the city, over several centuries.[820]

The corpus contains three main sets of tables with values given in degrees and minutes for each degree of solar longitude and each degree of solar altitude: (1) the solar azimuth; (2) the time before midday; and (3) the time since sunrise. These tables have some 10,000 values each. Single tables on one page each with 180 values serve various functions of spherical astronomy and the times of prayer. The latter include the earliest known

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820 See the text to n. 581 above.

tables for the duration of morning and evening twilight and the effect of refraction at the horizon.

The Cairo corpus, rediscovered around 1970, was previously unknown to modern scholarship even though the tables in it were used from the 10th to the 19th century. It later turned out to be one of numerous such sets for different localities such as Baghdad, Damascus, Jerusalem, Aleppo, Tunis, Taiz, Istanbul, *etc*.[821]

Now one of these tables for Cairo shows the altitude of the sun when it is in the azimuth of the *bādhahanj* throughout the year. The table is found at least in the following five manuscripts of the Cairo corpus of tables for timekeeping:[822]

- Dublin Chester Beatty 3673, copied 1371;
- Cairo MM 184, copied *ca*. 1700;
- Cairo DM 954,2, copied *ca*. 1475;
- Cairo MM 58,2, copied in 1450 by the astronomer Ibn Abi ‘l-Fatḥ al-Ṣūfī;
- Istanbul Nuruosmaniye 2925, no date.

The title – **Pl. S3** – reads:

جدول ارتفِاع الشمس اذا مرت بسمت الباذاهنج

“Table of the altitude of the sun when it passes through
the azimuth of the wind-catcher.”

More specifically, the table displays the solar altitude in degrees and minutes when the sun was in the direction of winter sunrise for each degree

[821] These manuscripts are all described in King, *Synchrony*, vol. 1 (2004), I: “A survey of (Islamic) tables for timekeeping by the sun”, on pp. 1-190, and II: “A survey of (Islamic) tables for regulating the times of prayer”, on pp. 191-456.

[822] See *Synchrony*, vol. 1 (2004), II: 252-262, on the manuscripts of the corpus, and pp. 270-271 for remarks on the table for aligning the wind-catcher.

of solar longitude (corresponding roughly to each day of the year).[823] In the summer months, the sun will have attained a certain altitude by the time it is in the direction of winter sunrise; this is the value that is tabulated. When the sun is actually at the winter solstice, it will be on the horizon when it is in the direction of winter sunrise, and the altitude given in the table should be, or might be expected to be zero. But, in fact, the altitude is given as 0°41′, because an attempt has been made to adjust the values for the effect of refraction at the horizon.[824] We are dealing with the first quantitative measure in the history of astronomy of the difference between the true horizon and the visible horizon[825] – see further below.

Now what should we make of such a table? The answer was soon to be found in various other astronomical manuscripts in Cairo and elsewhere. The wind-catchers of Cairo were astronomically aligned. What (on earth) did that mean?

Did Ibn Yūnus himself compile this table? He certainly could have, for in his monumental *Ḥākimī Zīj* he included tables of the solar altitude for 10 different values of the solar azimuth, of which the tables for azimuths 30° and 60° from the meridian are occasionally also found in copies of the

823 See "Ibn Yūnus' *Very Useful Tables* for reckoning time by the sun" (1973), pp. 368 & 371-373, and *Synchrony*, vol. 1, II: 268-271, on the tables for determining the *qibla* by means of the sun and for orienting a wind-catcher.

824 King, "Ibn Yūnus' *Very Useful Tables*" (1973), pp. 373-376; also, *Synchrony*, vol. 1, II: 275-278.

825 Anyone who might think that such tables would be of little significance for the history of astronomy in general might be surprised to learn that the table for the wind-catcher contains an adjustment for refraction at the horizon, the first evidence of a numerical value for the altitude difference between the true horizon and the apparent horizon. This feature has not attracted any attention amongst historians of astronomy, but neither has Islamic astronomical timekeeping in general.

Cairo corpus.[826] In the *al-Ḥākimī Zīj* Ibn Yūnus tabulated the altitude of the sun when it was in the azimuth of the *qibla*, taken as 38° S of E, and in the Cairo corpus this table reappears, together with another one based on a *qibla* of 37° S of E.[827] In addition, Ibn Yūnus tabulated in his *Zīj* the solar rising azimuth and the altitude of the sun in the prime vertical, both as functions of the solar longitude.[828] The former function has a maximum of 27°30′53′′ (Ibn Yūnus' value is accurately computed to seconds), which is, of course, the azimuth of the *bādahanj*.

The table for the wind-catcher in the Cairo corpus is less accurately computed than Ibn Yūnus' other tables of solar altitudes, with errors of up to ±5′, but this in itself does not argue against his authorship, because even this level of accuracy is hardly necessary: values to the nearest degree would be more than adequate for practical purposes. Also, the one part of the corpus which is definitely due to Ibn Yūnus is the part with the title كتاب السمت, *Kitāb al-Samt*, the set of tables of the azimuth (*samt*) of the sun for each degree of solar altitude and each degree of solar longitude, with around 10,000 values in degrees and minutes. The 14th-century astronomer al-Bakhāniqī in the introduction to his new arrangement of the corpus could be understood as implying that Ibn Yūnus followed this set with the table for the wind-catcher.[829] However, one copy of the table for the wind-catcher bears a marginal note stating that it was compiled by Ibn al-Rashīdī (**Pl. S4**), a somewhat elusive Egyptian astronomer who was involved in preparing two sets of tables for time-keeping for the latitudes

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826 King, *The astronomical works of Ibn Yūnus* (1972), pp. 217-222; "Ibn Yūnus' *Very Useful Tables*" (1973), pp. 364-365; also *Synchrony*, vol. 1 (2004), II: 268.

827 *Idem*, "Ibn Yūnus' *Very Useful Tables*", p. 368, and *Synchrony* (2004), II: 268-270.

828 King, *The astronomical. works of Ibn Yūnus* (1972), pp. 166-171 & 172-175.

829 King, *In Synchrony with the Heavens*, vol. 1 (2004), II: 290-295.

of Mecca and of Jerusalem *ca*. 1300.[830] He was also known to have corrected some of Ibn Yūnus' tables – the last few pages of the tables of solar azimuth as a function of solar altitude and solar longitude – where they had become corrupted by copyists and even by incompetent astronomers.[831] In MSS Dublin Chester Beatty 3673 and Gotha A 1410 the table for the *bādahanj* (with minimum entry 0°41′) is appended to sets of solar azimuth tables uncorrected by Ibn al-Rashīdī, which suggests an earlier complier than Ibn al-Rashīdī, possibly Ibn Yūnus himself.

In any case, the table is an anomaly in the history of astronomy. It is in fact an absurdity, for it is is quite superfluous. To align a wind-catcher with respect to winter sunrise in a city in which the principal buildings are oriented with respect to winter sunrise, one does not need any table. To align one in other parts of the city is easy when everyone would have known the direction of winter sunrise. One could also question the need for the table of solar altitude in the azimuth of the *qibla* which Ibn Yūnus computed. Who would ever need it? Was the Cairo corpus of tables for timekeeping actually needed? And what about all the extensive tables for astrological purposes which survive from over the centuries? Or the tables for determining the date of Easter in Islamic *zīj*es? In December, 2019, I saw a manuscript handbook of Jewish chronological tables from Prague, *ca*. 1800, containing over 600 pages of tables, which belonged to the ancestors of a friend in Frankfurt. When it comes to astronomical tables,

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830 King, "Astronomy in medieval Jerusalem" (2018), also C*airo Survey*, no. C39, and Rosenfeld & İhsanoğlu, *Mathematicians, astronomers and other scholars of Islamic Civilisation* (2003), pp. 252-253, no. 743. See also the text to n. 860 below.

831 For example, Ibn Yūnus' tables of solar azimuth for Cairo serve each integral degree of solar altitude up to the maximum for Cairo, namely, 83°. Some inept soul extended them up to 90° with a set of absurd and meaningless sub-tables, which still survive in some copies of the corpus – see *Synchrony*, II: 251 & 285 for details. How he calculated these values is not at all clear.

it is sometimes better not to ask whether they were ever needed or whether they were ever used.

(A technical digression: a correction for refraction at the horizon)

The table of the solar altitude in the azimuth of the *bādahanj* which is attributed to Ibn al-Rashīdī in one source – **Pl. S4** – has the sun descend to an altitude of 0°41´ at the winter solstice rather than 0°0´, which Ibn Yūnus would surely have favoured, or would he? This is a correction for horizontal refraction, that is, the amount the true horizon is below the visible one. Mamluk astronomers, perhaps Ibn Yūnus before them, were the first to associate a numerical value to this, namely, $^2/_3$°, which is an excellent value. They attributed the corresponding times taken by the sun to pass between these two horizons, called دقائق الاختلاف, *daqā'iq al-ikhtilāf*, "difference minutes", at the equinoxes and solstices (in equatorial minutes) as:

EQ: 47 — SS: 62 — WW: 32 .

Herein lies surely a distortion of what was original stated, because Ibn Yūnus was a master of spherical astronomy. The values that can be derived from the tables of time since sunrise / before sunset as a function of solar altitude and solar longitude which are associated in some manuscripts with the name of Ibn Yūnus (taking two-thirds of the values for altitude 1°) are:

EQ: 47 — SS: 53 — WW: 53 .

A hypothesis proposed in my 1973 paper on the Cairo corpus was that Ibn Yūnus had somewhere stated that the difference minutes were 47 at the equinoxes and increased about 5´ to maxima at the solstices.[832] This would then have been misinterpreted by later astronomers who were not in a position to recognize the incorrectness of what they themselves proposed,

832 On the "difference minutes" see King, "Ibn Yūnus' *Very Useful Tables*" (1973), pp. 373-376, & *Synchrony*, vol. 1 (2004), II: 275-278 & 336-339.

namely, 47′ at the equinoxes and 5′ for each sign up to a maximum at the summer solstice and down likewise to a minimum at the winter solstice.

It is important to differentiate between, on the one hand, the excellent quantitative estimate of the difference between the two horizons and the accurate value for the time taken by the sun to move between these two horizons at the equinoxes, and, on the other, the misguided adjustments for the solstices. The latter do, however, give the impression of someone not so gifted misquoting someone who knew what they were doing (Ibn Yūnus).

Corrections for the "difference minutes" were also used in prayer-tables in Mecca, Crete, Damascus and Istanbul. One hapless fellow, ʿAbd al-Qādir al-Minūfī, went so far as to tabulate the "*daqā'iq al-ikhtilāf*" for all latitudes based on the unhappy base-values and an approximate procedure for making the table universal.[834]

In our sources there is no mention of Ibn Yūnus' late contemporary Ibn al-Haytham, who did discuss refraction but is not known to have derived a numerical value for refraction at the horizon. This tradition is apparently unknown to modern writers on the history of measurements of atmospheric refraction. This entire tradition is not mentioned in Lehn & Van der Werf, "Atmospheric refraction: a history" (2005).[835] As far as I know, the only scholar to have cited this material is Len Berggren in his popular book on the history of Islamic mathematics.[836]

Ibn Yūnus and the orientation of the *bādahanj*

834 *Synchrony*, II: 336-339 & fig. 7.2c on p. 321.

835 It is, for example, not mentioned in Lehn & Van der Werf, "Atmospheric refraction: a history" (2005). In our sources there is no mention of Ibn al-Haytham, who did discuss refraction but is not known to have derived a value for refraction at the horizon.

836 Berggren, *Episodes in the Mathematics of medieval Islam* (1986), p. 181.

Now the orientation of the wind-catcher and its construction is specifically featured in a set of notes attributed to Ibn Yūnus in a Milan Ambrosiana manuscript, to which we shall return. Therefore, I am inclined to hypothesize that it was Ibn Yūnus who, confronted with the new Fatimid city-plan fortuitously aligned with the winter solstice, proposed that the wind-catchers be aligned with the street-plan for aesthetic reasons, and nevertheless, by a cunning design, be open to all favourable winds. It was perhaps problematic enough that the new Fatimid mosques – al-Ḥākim and al-Azhar – be oriented in Ibn Yūnus' new *qibla* direction (37° S of E) rather than the *qibla* of the Companions (27° S of E) which fortuitously underlay the city-plan, without having substantial constructions on the roofs of buildings that were aligned due north. It would be nice to have a contemporaneous discussion of this! On the other hand, the air-shafts inside the buildings would be already in line with the street-pattern outside and the object of the instructions in the astronomical texts was to *ensure* that the wind-catchers on top were aligned in association with the local theory of the winds, which, it so happened, corresponded with the street-alignment. Clearly the sides of the wind-catchers could have simply been aligned with the edge of the roofs on which they were erected. But Egyptian astronomers from Ibn Yūnus onwards loved compiling tables, and this is just one such.[837] Ibn Yūnus' table, if such it was, was a veritable *excès de délicatesse*, but it has certainly served its purpose in modern times.

In brief, part of the historical importance of the wind-catchers was that they were built according to the specifications of the medieval Egyptian astronomical texts. These took into consideration local theories of the winds. And it was just this kind of wind-catcher that excited medieval poets and littérateurs and architects and astronomers alike, let alone, in

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[837] In fact, they produced more tables than any other astronomers elsewhere in the medieval Islamic world: see King, *In Synchrony with the Heavens*, vol. 1 (2004), esp. I: 167-169, 173-174, 175-182, II: 247-347, and VIb: 711-739.

modern times, one English orientalist and one French architecture historian.

18 — On the folklore of the winds in medieval Egypt

> "A *bādahanj* whose wind
> Kindles the fires of violent passion
> I have praised, not knowing it,
> And my praise went up into the air."
> The littérateur Ibn Abī Ḥajala at-Tilimsānī (1325-1375), cited in Franz Rosenthal, "Poetry and architecture: The *bādhanj*" (1977), pp. 12-13.

We have seen that the wind-catchers of medieval Cairo were aligned in accordance with the street-pattern, which was fortuitously aligned perpendicular to the *qiblat al-ṣaḥāba*, that is, winter sunrise. To start with, of course, it was the Pharaonic/Roman Red Sea Canal which was fortuitously perpendicular to to winter sunrise. But we have also seen a medieval text which implies that *bādahanj*es should be aligned with winter sunrise anywhere in Egypt. This we can now explain.

In a substantial number of medieval Arabic texts relating to folk astronomy rather than to mathematical astronomy, we find statements about the winds: their number, their names, and the directions from which they blow.[838] Similar details are recorded by the medieval Arab lexicographers.[839] The limits for the winds, that is, the boundaries of the sectors of the horizon from which they are thought to blow (called in Arabic مهب, *mahabb*), are always astronomically defined in terms of the

[838] See the articles "Maṭlaʿ (rising points)" by D. A. King, and "Rīḥ (winds)" by Miguel Forcada in *Enc. Islam*, 2nd edn.

[839] See, for example, Lane, *Arabic-English Lexicon* (1863), *sub shamāl*, *ṣabā*, *qabūl*, *janūb* and *dabūr*.

cardinal directions, or sunrise and sunset at midwinter and midsummer, or the rising and settings of particular stars.

The schemes are not generally associated with any particular locality, but some of them may be of Hejazi provenance. We have already seen the wind-scheme associated with the Kaʿba.[840] These Arab wind schemes constitute a meteorological tradition quite independent of the classical traditions represented in the writings of Aristotle and Theophrastos, which were translated into Arabic in the 8th and 10th centuries, respectively.[841] This Arab tradition of the winds has therefore attracted no serious interest.

Ibn al-Biṭrīq

Saʿīd ibn al-Biṭrīq (877-940) was the Melkite patriarch of Alexandria, author of works of medicine, history and apologetics, also of a paraphrase of Aristotle's *Meteorology*. The Dutch Orientalist and historian of philosophy Paul Lettinck, in his book on the Arabic tradition of Aristotle's *Meteorology*, mentions Ibn al-Biṭrīq on the different winds and their directions:[842]

> "There are twelve winds. The common people distinguish four winds: the north wind (*shimāl*), the south wind (*janūb*), the east wind (*ṣaban*) and the west wind (*dabūr*). Between the north and east/west winds are two other winds, one nearer to the north and the other nearer to the east/west. Between the south and west/east winds are two other winds, one nearer to the west/east and the other nearer to the south."

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840 See n. 647.

841 The sources for early Islamic meteorology (to *ca*. 1050) are documented in Sezgin, *Geschichte des arabischen Schrifttums*, VII.

842 Article "Saʿīd ibn al-Biṭrīq" in *Enc. Islam*, 2nd edn., by the French historian of the medieval Muslim world, Françoise Micheau, and on this text see Lettinck, *Aristotle's* Meteorology *and its Reception in the Arab World* (1999), pp. 3 and 168.

It is difficult to imagine "the man in the street" differentiating between more than the standard four winds with Arabic names, yet our next source shows that all manner of theories about the winds, bordering on the absurd, were circulating, at least in books.

The anonymous 11th-century *Book of Curiosities*

Since I first wrote on the topic of Egyptian wind-schemes in the early 1980s, there has surfaced a precious manuscript of an anonymous Egyptian treatise on geography and non-mathematical cartography from the 11th century, acquired by the Bodleian Library in Oxford. The title of this work is كتاب غرائب الفنون وملح العيون, *The Book of curiosities of the sciences and marvels for the eyes*.[843] The text is rich in information about all manner of subjects including the winds in various locations, and has been exploited to the full by its modern editors, Emilie Savage-Smith and Yossef Rapoport. Amongst the information on the winds in Cairo in Egyptian folklore we find the same scheme that I had previously cited from the late-14th-century scholar al-Qalqashandī.

al-Qalqashandī

al-Qalqashandī in his encyclopaedic work *Ṣubḥ al-aʿshà* presents the same scheme as the anonymous author of the *Book of Curiosities* for the limits of the winds.[844] In this scheme the winds blow from the quadrants defined by the cardinal directions. The author is no astronomer, for he talks carelessly about sunrise and sunset without specifying that he is talking only about the situation at the equinoxes. The relevant passage reads as follows:

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843 Savage-Smith & Rapoport, *An Eleventh-Century Egyptian Guide to the Universe* (2014), index *sub* 'wind', and especially p. 411, n. 18.

844 al-Qalqashandī, *Ṣubḥ al-aʿshà*, II, pp. 175-177. I have not identified the author of the book entitled *Ṣināʿat al-kuttāb*.

اصول الرياح اربعة الاول الصبا وهي التي تأتي من المشرق ... ... قال في صناعة الكتاب واهل مصر يسمونها الشرقية لانها تأتي من مشرق الشمس ... ... والثانية الدبور ومهبها من مغرب الشمس الى حد القطب الجنوبي ... ... والثالثة الشمال ... ... ومهبها من حد القطب الشمالي الى مغرب الشمس ... ... الرابعة الجنوبية ومهبها من حد القطب الاسفل الى مطلع الشمس وتسمى بالديار المصرية القبلية لانها تأتي من القبلة فيها ... ... وهي اردأ الرياح عند اهل مصر ...

> "The main winds are four. The first is the *ṣabā* which is the one that comes from the east [*sic*, read from between the east and the north]. The author of the book *Ṣināʿat al-kuttāb* said that the Egyptians call it the *sharqiyya* because it comes from the rising point (*mashriq*) of the sun ... . The second is the *dabūr* and it blows from between the setting point of the sun and the direction of the south celestial pole. ... The third is the *shamāl* ... and it blows from between the direction of the north celestial pole and the setting point of the sun. ... The fourth is the *janūbiyya* and it blows from between the direction of the south celestial pole and the rising point of the sun. It is called *qibliyya* in Egypt because it comes from the *qibla* there ... and it is the worst of the winds according to the Egyptians."

al-Qalqashandī's wind-scheme and its relation to the kind of *bādahanj* described in the texts associated with Ibn Yūnus in the Ambrosiana manuscript is shown in **Pl. S6**. Notice that both the open and the closed parts correspond to 180° on the horizontal scale. It appears that some *bādahanj*es in Cairo such as that on the Musāfirkhāne, having the width equal to one half of the length, were constructed to catch both the *shamāl* and the *ṣabā*, in conformity with this tradition of popular local folklore.

Note also that al-Qalqashandī states that the south wind is called *al-qibliyya* in Egypt, "because it comes from (the direction which is) the *qibla* (in Egypt)".[845] As already noted, this expression is still in use in Egypt and elsewhere.

Najm al-Dīn al-Miṣrī and Ibn al-Qāṣiḥ

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[845] Badawi & Hinds, *Dictionary of Egyptian Arabic* (1986), p. 684. See the text to n.723above.

As we have seen, Najm al-Dīn al-Miṣrī and Ibn al-Qāṣiḥ describe a different kind of wind-catcher, with the width equal to one quarter of the length. In this variety, angles of 153° and 207° for the open and closed parts of the *bādahanj* are indicated. Najm al-Dīn's text reveals that the western side of the wind-catcher is to be open to the wind as well as the principal northern side, as in the case of the *bādahanj* in the Musāfirkhāne Palace. His diagram indicates the reason: the favourable northerly winds (*ṭiyāb*) were thought to blow from points between due east and summer sunset, and the unfavourable southerly winds (*marīs*) from points between summer sunset and due east. This second wind-scheme and its relation to the kind of *bādahanj* described by Najm al-Dīn al-Miṣrī and Ibn al-Qāṣiḥ is shown in **Pl. S7**.

We now see why the medieval sources cited above state that the wind-catchers in Egypt as a whole, rather than just Cairo, were to be erected in line with winter sunrise. Only in Cairo did the street-plan also lie in this direction. The wind-schemes were thought to be valid everywhere, at least in Egypt. We seen in **Ch. 14** that the parts of the horizon whence the winds hail according to the predominant wind-scheme in early medieval Mecca are related to the walls and corners of the Kaʿba.

I am not aware of the existence of any other medieval treatises in which the limits of the winds in Egypt are discussed in detail. The ʿIrāqī scholar al-Masʿūdī (*ca*. 896-956) discusses the winds in Egypt, and implies that they blow from the cardinal directions when he observes that each one corresponds to a side (ركن, *rukn*, actually, "corner") of the pyramids.[846] Likewise, al-Maqrīzī implies that the four winds blow from the cardinal directions.[847]

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[846] al-Masʿūdī, *al-Tanbīh wa 'l-ishrāf*, text, pp. 16-21, transl., pp. 25-36. On the author see the article in *Enc. Islam*, 2nd edn. by Charles Pellat.

[847] al-Maqrīzī, *al-Khiṭaṭ*, II, p. 263.

Arabic medical texts on the healthy effect of fresh air

> "The common factor linking all the aforementioned authors (of twenty Arabic medical tracts up to *ca*. 1300) is that they were all concerned with environmental pollution and how to protect human health from its effects." Lutfallah Gari, "Arabic treatises on environmental pollution up to the end of the 13th century" (2002), p. 486.

The only reason for including this section is to draw attention to the 20 early Arabic medical treatises studied by the Saudi scholar Lutfallah Gari. The quotations from the works of the great al-Rāzī and Ibn Sīnā presented in **Ch. 4** above are not particularly helpful for our present purposes, and I refrain from looking at any other medical sources.

The Frenchman Volney reflects on the weather in Egypt and Syria

Constantin François de Chassebœuf, *comte* (count) de Volney (1757-1820), was a French philosopher, abolitionist, historian, orientalist and politician. He was at first surnamed Boisgirais after his father's estate, but afterwards assumed the name of Volney (which he had created as a contraction of Voltaire and Ferney).

Volney's interest in Classics led him to embark on a journey to the East in late 1782 and he reached Ottoman Egypt, where he spent nearly seven months. Thereafter, he lived for nearly two years in Greater Syria in order to learn Arabic. In 1785 he returned to France, where he spent the following two years compiling his notes and writing his *Voyage en Egypte et en Syrie*, which was published in 1787, and *Considérations sur la guerre des Turcs et de la Russie* in 1788. Unfortunately, his other adventures in the United States and his declaration of the mythical nature of Jesus do not concern here.

His remarks on the weather in Egypt and Syria are presented in detail and only no précis will be offered here.[848] He says not a word about wind-catchers in Cairo or in Syria.

Reflections on the weather in Egypt

For information on the winds in Egypt in my 1984 paper I referred, for lack of any other sources, to a 1916 British military document.[849] It is now time to turn to non-military sources, so I present a 17th-century English account and a 21st-century one. Olivier Jaubert has already signalled some literature in French from Egyptian sources.[850]

The English traveller Edward Brown, a former merchant, visited Egypt in 1673-74 and wrote the following account of the weather in Egypt:[851]

> "The Air of Egypt, according to some Writers, is the most foul and unwholesome in the World, in the Judgment of others, the most serene and salubrious. For my own Part, I think them both in the Right, and both in the wrong, as I shall shew by stating this Matter truly. November, December, January are the Winter Months, wherein the Franks and the Turks wear Garments lined with Furs, believing the Weather to be very cold; in fact however it is not so, but the Disposition of their Bodies makes them have a very quick Sensation, as I easily discerned by myself. I arrived in the Winter, and thought the Weather very moderate, but the next Winter I felt it very cold, and yet by my Glass it appeared that the former Winter

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848 Volney, *Voyage en Égypte et en Syrie* (1959, pp. 50-57 (Egypt) and 171-177 (Syria).

849 "I.D. 1117", *Notes on climate and other subjects in Eastern Mediterranean and adjacent countries prepared on behalf of the Admiralty and the War Office*, 1916.

850 Jaubert, "Capteurs de vents" (1995), p. 172, n. 13. Another source is Marcel Clerget*, Le Caire – Étude de géographic urbaine et d'histoire economique* (1934), I, pp. 61-73 (not seen).

851 *Travels and adventures of Edward Brown, Esq*. (1739 edn.), pp. 308-309.

> had been colder. To the Winter succeeds a Spring of about six Weeks, which is very pleasant. About the Vernal Equinox the South Winds begin to blow, and they blow more or less till the Sun reaches the Tropic of Cancer. The Arabians call these Winds Chamsin, i.e. of Cambyses [*sic*]; because it was by these Winds that his Army perished in their Ethiopian Expedition; then it is that Egyptian Air is unwholesome. These Winds blow sometimes three, four, or five Days together, and then for a Day or two there is a Breeze from the North; sometimes they blow for nine, ten, eleven, or twelve Days, and then the Air is pestiferous, and Multitudes die of an Hour's Sickness. All this however is uncertain, for some Years they do very little Mischief, and in other Years again they do a great deal. This only is certain, that they begin to blow about the Equinox, and that they cease blowing on the rising of the Nile, viz. 17th of June. Immediately after this, the North and West Winds blow constantly Night and Day, and so temper the Heat of the Climate, that it is far from being either intemperate or unwholesome. This pleasant Season of the Year continues from the middle of June till towards the End of September, during which Space the Country being overflown, the Inhabitants give themselves up wholly to Pleasure, to which indeed they are always prone."

With all this detail about the winds, Brown ignored the wind-catchers which graced most houses, as recorded, for example, by his Turkish contemporary Evliya Chelebi. It was these which "tempered the heat of the climate", at least for those indoors.

The following information was kindly provided by Dr. Giles Nicklin of Washington, DC, in June, 2019:

> "This link accesses an automated weather station at Cairo Airport.[852] It shows that for the 10-year period 2008-2017, the wind blew from a northerly direction (from the NW, N, or NE) for a total of 68% of the time. The reason the air mainly flows from the north is likely to be a combination of localized sea-breezes caused by the hot land of Egypt compared to the cooler sea as well as larger-scale weather systems over the eastern

[852] www.weatheronline.co.uk/weather/maps/city?.

> Mediterranean. The air coming from the sea will be at roughly the temperature of the sea. The available data shows the eastern Med reaches a maximum of 25°C in July / August and a minimum of 16°C in January / February, so the air will arrive over the Nile Delta at these kinds of temperatures and then slowly warm up as it flows south over the warmer Egyptian land surface. Air in the 16°C-25°C range is obviously going to feel a lot more comfortable than air heated to the (high) temperatures of the buildings, so you can see why the wind-catchers would have worked so well. The notable exception to the prevailing flow of air from the north is when a low pressure area forms over the central Mediterranean creating conditions for the Sirocco (*khamsīn* in Egypt) in which winds blow to the north bringing very hot dusty air from the N. African deserts."[853]

Since 2006 a Wind Atlas for Egypt has been available, published by the New and Renewable Energy Authority (NREA), the Egyptian Meteorological Authority (EMA), and the Technical University of Denmark (DTU Wind Energy).[854]

We can also heed an Egyptian academic meteorologist, S. M. Robaa of the Astronomy and Meteorology Department at Cairo University, who made measurements of the wind over a 5-year period, although his goal was to primarily to investigate the differences between the winds in different parts of the city (rural, urban, suburban).[855] His summary:

> "Air temperature, vapour pressure and relative humidity differences at fixed hours in urban, suburban and rural districts of Cairo area, Egypt, have been investigated using data for the 1995-2000 period. It has been found that, on the basis of the vapour pressure differences, the urban atmosphere is drier throughout the year except for the months of

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853 www.weatheronline.co.uk/reports/wind/The-Sirocco.htm.

854 www.wasp.dk/dataandtools#wind-atlas__wind-atlas-for-egypt. See also www.vindenergi.dtu.dk/english.

855 Robaa, "Urban-suburban/rural differences over Greater Cairo" (2003).

December, January, May and September. In the afternoon, the atmosphere in the urban area is more humid throughout the year if compared to the suburban area and during the months from October to January in addition to May if compared to the rural area. On the basis of relative humidity, the urban atmosphere is always drier than its surroundings throughout the year, except in the afternoon when the urban-rural differences fluctuated between positive and negative. The urban atmosphere is always warmer than its surroundings throughout the year, except in November when there is a cool island. Relationships between heat island intensity and both vapour pressure and relative humidity differences reveal that local effects can be significant."

His graphics do not show a predominance of a southerly wind in any month of the year, which, for Cairenes, is a good thing.

Table 1. The wind directions at the urban, suburban and rural areas in Greater Cairo during the study period (1995-2000).

Month / Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rural	↘	↓	↙	↘	↓	↘	↘	→	↘	↙	↘	↓
Urban	↙	↙	↙	↙	↙	↙	↓	↘	↘	↘	↘	↙
Suburban	↘	↘	↘	↙	↙	↙	↓	↙	↙	↙	↓	↓

Table 2. The seasonal wind speed values at the urban, suburban and rural areas in Greater Cairo during the study period (1995-2000).

	Area		
Season	Urban	Suburban	Rural
Winter	4.2	7.2	6.0
Spring	5.4	9.0	7.3
Summer	4.1	8.4	6.9
Autumn	3.0	7.6	6.4

A somewhat mysterious outfit called weatherspark.com, with no apparent credentials or base, but serving the needs of tourists (with "tourism scores"

and "beach/pool scores"), has produced graphics for wind speeds and directions at Cairo for the whole year.[856] Their conclusions:

> "The wind is most often from the north for 9.8 months, from February 23 to December 17, with a peak percentage of 86% on August 27. The wind is most often from the west for 2.2 months, from December 17 to February 23, with a peak percentage of 35% on January 1."

The graphics is programmable (with a click here and there, but no instructions), so that **one can see the wind direction for any time of any day of the year (!)**. There is no mention of the fact that the weather is going to vary from year to year.

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Another personal note. Living in Egypt or the Sudan one gets used to day after day of sunshine, and month after month of no rain. But the unfavourable winds are something else. Well I remember the *khamsīn*s in Egypt, which I experienced in the 1970s, and, even more so, the far worse *habūb*s in the Sudan, which I lived through in the 1960s. Try an electric sandstorm in the desert outside Khartoum. Or try a sandstorm on the desert road from Cairo to Alexandria, in which all cars travelling on the road would get sandblasted and stripped of paint. And, talking of weather, and just for the record, the only country where I have ever come close to freezing to death in the open is the Sudan.

[856] https://weatherspark.com/y/96939/Average-Weather-in-Cairo-Egypt-Year-Round.

19 — The Cairo wind-catchers in other astronomical texts

> "Chaque jour amène quelque découverte nouvelle et vient démontrer l'extrême importance d'un examen approfondi des manuscrits de l'Orient." / "Each day brings with it some new discovery and demonstrates the extreme importance of an in-depth study of the manuscripts of the Near East." L. A. Sédillot, whose privilege it was to have access to the rich collection of Arabic scientific manuscripts in the Bibliothèque Impériale in Paris, in "Mémoire sur les instruments astronomiques des Arabes" (1844), pp. 24-25. (His remark is equally true today for the collections in Paris, Dublin, London, Berlin, El Escorial, Vatican, Florence, Milan, Istanbul, Tehran, Qum, Mumbai, *etc*., not forgetting Cairo.)

Apart from the table for aligning a *bādahanj* in the main Cairo corpus, we have various medieval Egyptian astronomical treatises which refer to the device.

Ibn Yūnus again

In an Egyptian collection of short treatises attributed to Ibn Yūnus which is preserved in the MS Milan Biblioteca Ambrosiana C49, copied *ca*. 1300, we find instructions (on fol. 110v) for setting up the *bādahanj*.[857] The text reads:

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[857] On this manuscript see no. C49: item 281e - Trattado sul metodo di trovare la meridiana di Ibn Yunes, il celebre astronomo di Hakim biemrillah", at von Hammer-Purgstall (1774-1856), *Catalogo dei codici arabi, persiani e turchi della Biblioteca Ambrosiana* (1839), pp. 43-44. In the second catalogue of the collection by the Italian orientalist Eugenio Griffini (1878-1925), "Lista dei manuscritti arabi, nuovo fondo della Biblioteca Ambrosiana di Milano", this manuscript does not seem to appear, the number C49 being associated with another manuscript. (I have checked nos. 277-C21 through 345-C89 in *Rivista degli studi orientali* 7 (1916-18). Carl Brockelmann

... معرفة اخراج البادهنج استخرج الجهات الاربع ثم عد من نقطة المشرق طالبا الجنوب بمقدار سعة مشرق الجدي ثم مد عليه خطا هو خط البادهنج ربعه بخط آخر واقم المحلة على ذلك التربيع واحسن ما يكون ان تقسم وجهه بعشرة اجزاء مثلا وتجعل جنبه منها خمسة ونصف هذا الذي وقع عليه الاصطلاح من اهل الصناعة والله تعالى الموفق ...

"To mark the direction of the *bādahanj*, first establish the four cardinal directions, and then count from the east-point southwards by the amount of the rising amplitude of (the sun at the first point of) Capricorn. Next extend a line (from the centre) in this direction, and this will be the direction for the ventilator. Form a rectangle with another line, and set up the *maḥilla* on this rectangle (*rabbiʿhu bi-khaṭṭ ākhar wa-aqimi 'l-maḥilla ʿalà dhālika 'l-tarbīʿ*). A good procedure (for laying out the direction of the *bādahanj*) is to divide the front in ten parts and make the side five and one-half, according to the technical convention of the craftsmen. God Almighty grants success."

These instructions in terse, crisp technical Arabic were clearly written by a scholar of standing. It was not unheard of in medieval scientific writing that the author should present a highly technical procedure for finding, say, the *qibla*, and then present simple procedures for architects, workmen or even laymen, to achieve the same result with an insignificant error: such was the presentation of the great scientist al-Bīrūnī in finding the *qibla* at

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(*Geschichte der arabischen Litteratur*, I, p. 256), mentions a signature 289b for a Milan treatise by Ibn Yūnus, but 289-C33 is not what we are looking for. The manuscript reappears with the number 227 in the third catalogue of the Ambrosiana manuscripts, by Löfgren & Traini, *Catalogue of the Arabic manuscripts in the Biblioteca Ambrosiana*, vol. 1 (1975), p. 72.

The same precious manuscript – the real C49 – contains a treatise by Najm al-Dīn al-Miṣrī (Chs. 13, 18-19) and the astrolabe treatise by the Andalusī astronomer Abu 'l-Ṣalt, written whilst the author was in a Cairo prison *ca*. 1050. Fortunately, I have a microfilm of the sections attributed to Ibn Yūnus.

On this text see King, "Ibn Yūnus' *Very Useful Tables*" (1973), p. 372; "Architecture and astronomy: the ventilators of medieval Cairo" (1984), pp. 108-109 / *In Synchrony with the Heavens*, vol. 1 (2004), VIIb: 794.

Ghazna in several different ways, taking the average of the results which differed only in the seconds, and then offering a series of simple methods which anybody could follow – so many units south, so many units west – to arrive at virtually the same result.[858]

From this text we might conclude that the term مَحِلَّة, *maḥilla*, not vowelled here but indeed vowelled elsewhere (in the treatise of Ibn al-Qāṣiḥ), which is not attested in any medieval or modern Arabic dictionary known to me, refers to the entire wind-catching device or wind-scoop, corresponding to the modern word *malqaf*. Other sources, however, do not confirm this.

The ratio for the lengths of the front and side of the *bādahanj*, namely, $10:5^1/_2$, ensures that the diagonal is almost precisely east-west. (Actually the direction for the *maḥilla* attained by this operation is about 29° S of E.) Observe also that the western side of this *bādahanj* is open to the winds; it appears that this design was in accordance with a wind-scheme – see **Ch. 18**. The plan and orientation of the *bādahanj* as outlined in this text is displayed in **Pl. S6**. Notice that the *bādahanj* on the Musāfirkhāne was about twice as wide as it is deep, as one can see by counting the wooden arches around the base. However, another medieval astronomical source points to a different arrangement for the base of the *bādahanj* – see below.

The author of this text, if not Ibn Yūnus himself, is not claiming to have invented the wind-catcher, but rather simply advocating setting it up **"according to the technical convention of the craftsmen"**.

Ibn al-Rashīdī

The table illustrated in **Pl. S4** is of particular interest. It is found in MS Cairo Dār al-Kutub *mīqāt* 758, fol. 4r, in a mid-17th-century Egyptian copy of the auxiliary tables for solving problems of spherical astronomy

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858 Kennedy, *A Commentary upon Bīrūnī's Taḥdīd* (1973), pp. 214-215, also mentioned in King, "The Ottoman mosques fallacy" (2018).

for all latitudes by the 14th-century Syrian astronomer Shams al-Dīn al-Khalīlī.[859] In the title:

جدول ارتفاع سمت الباداهنج لابن الرشيدي

the "table of the altitude (of the sun) in the azimuth of the *bādāhanj*" is attributed to the Egyptian astronomer Ibn al-Rashīdī who was active *ca*. 1300 (see above).[860] No other copy of the table makes this claim and I am tempted to dismiss it, not least because he is not known to have compiled any other original tables for Cairo.

On the left-hand side of the Cairo copy of the table there is a note which reads:

> في معرفة سمت الباداهنج لكل عرض وهو ان تستخرج سعة المشرق لرأس الجدي فما خرج معك فهو سمت الباداهنج والله اعلم ...
>
> "To find **the azimuth of the *bādahanj* for every latitude**, you determine the rising amplitude (of the sun) at the first point of Capricorn, and the result is the azimuth of the *bādahanj*, (but) God knows better."

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[859] On al-Khalīlī, whose work represents the pinnacle of the Muslim achievement in spherical astronomy, see my articles in *DSB* and *BEA*. On his tables, such as set of universal auxiliary tables for solving all of the standard problems of spherical astronomy for any latitude, and a table showing values of the *qibla* for each degree of latitude and each degree of longitude difference from Mecca, see King, *In Synchrony with the Heavens*, vol. 1 (2004), esp. II, Ch. 10: "The Damascus corpus of al-Khalīlī", pp. 358-401.

Such Islamic auxiliary tables, which have a history from the 9th to the 16th century (*Synchrony*, vol. 1, pp. 161-183) were not available to or even known to European astronomers in the Renaissance and early modern period. Those of Renaissance astronomers such as Regiomontanus (1463), Erasmus Reinhold (1554), and Magini (1604) – see *Synchrony*, vol. 1, pp. 184-190, esp. 188-189 – were less sophisticated and less useful than those of al-Khalīlī.

[860] On Ibn al-Rashīdī see King, "Astronomy in medieval Jerusalem" (2018), also *Cairo Survey*, no. C39, and the text to n. 830 above.

By this remark it is implied that the orientation of wind-catchers with winter sunrise was not to be practised in Cairo alone. For different latitudes the direction of winter sunrise is different; from this text we might anticipate that the azimuth of the *bādahanj* is *ca*. 27$^3/_4$° S of E for Alexandria, *ca*. 27 $^1/_4$° for Cairo, and *ca*. 25° for Aswan. The only problem is that few wind-catchers are known for any of these locations outside Cairo, although they were to be found in Qusair on the Red Sea coast, Minya on the Nile, and perhaps in al-Dasouq in the Delta – **Pls. C15 & E8**.

Najm al-Dīn al-Miṣrī

An anonymous Mamluk treatise describes and illustrates some one hundred astronomical instruments known to or invented by the author. It survives in two early copies preserved in the Chester Beatty Library in Dublin (Or. 102) and the Museum of Islamic Art at Doha, Qatar. The author has been identified as the early-14th-century Egyptian astronomer Najm al-Dīn al-Miṣrī.[861] The entire text and illustrations have been edited from both manuscripts, translated and commented upon by François Charette.[862]

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861 Najm al-Dīn is not well served in the bio-bibliographical literature. Suter, *Mathematiker und Astronomen der Araber und ihre Werke* (1900), no. 189, is already confused, Rosenfeld & İhsanoğlu, *Mathematicians, astronomers and other scholars of Islamic civilisation* (2003), p. 320, no. 954, yet more so.

The confusion is sorted out in *Cairo Survey* (1986), no. C26; Charette, *Mathematical instrumentation* (2003), pp. 24-41, esp. 28-31; King, *World-Maps for finding the direction of Mecca* (1999), p. xxix, and the references in *In Synchrony with the Heavens*, vol. 1 (2004), pp. 904, and vol. 2 (2005), p. 1041.

862 Charette, *Mathematical instrumentation in 14th-C Egypt* (2003), esp. pp. 222, 318-319 (translation), Arabic pp. 102-103 (text). See also King, "Architecture and astronomy", pp. 109-111 / *Synchrony*, VIIb: 795-799.

When the anonymous Dublin manuscript (Chester Beatty 102) was discovered in the 1970s, I falsely assumed that the treatise was by the Aleppo astronomer Ibn

This spectacular but highly enigmatic work contains an informative chapter on the wind-catcher, detailing different varieties (alas, not illustrated!). It also explains how one should adapt the wind-catcher that faces roughly NNE to receive the winds which hail from between the NNW and the NNE: the western side of the edifice is open, whereas its eastern side is closed. This is precisely the case with the splendid wind-catcher on the Musāfirkhāne shown in **Pls. R1-3**. The medieval wind-catchers were laid out so as to be perpendicular to the early *qibla* of winter sunrise at roughly ESE.

In the Chester Beatty Library manuscript, the discussion of the *bādahanj* occurs on fol. 52v – see **Pl. S5**. The text reads as follows:

الباب صا في معرفة وضع محلة البادهنج واسمائه وقدر الهوا الطياب وقدر الهوا المفسود من
قسمة دائرة الافق لذلك العرض اما اسمائه فهو اربعة فراتي ومجنح وكلي وعادلي فاما الفراتي
فهو القائم على سطح مستقيم واما المجنح فهو القائم على سطح مجنح كاجنحة الطير واما الكلي
فهو السطح المائل واما العادلي فهو الذي يكون بجنب حائط فاذا اردت وضعه فهو ان تدير دائرة

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al-Sarrāj, the leading instrument-maker of the 14th century. The assumption was made partly on the basis that the tables in the work were for latitude 36°, clearly serving Aleppo, but we now know of a series of leading astronomers who prepared tables for the latitude of the 4th geographical climate, that is, the middle of the inhabited world, taken as 36°, and the author of this treatise was one of them. Furthermore, no astronomer in Cairo was known who would have compiled such a treatise. Ibn al-Sarrāj was the obvious candidate. On the other hand, Ibn al-Sarrāj was a genius, and the author of this treatise was something of a nutcase. Besides, Ibn al-Sarrāj worked in Aleppo, so why would he be writing about Cairene *bādahanj*es?

It was François Charette who in the 1990s first established that the author was the Cairene astronomer Najm al-Dīn al-Miṣrī, which immediately explained the presence of a chapter on the Cairene *bādahanj* in a Mamluk Egyptian astronomical treatise.

Emilie Savage-Smith confuses the situation again in her “Some medieval Arabic *marginalia*” (2005), pp. 84-85, by not citing the appropriate available literature.

كاملة وتربعها وتمد خطا من سعة مشرق الجدي الى سعة مغرب السرطان بتلك البلد فهو محلة البادهنج في البلاد البعيدة عن البحر المالح مثل سكندرية ودمياط وعيذاب وجدة وما اشبه ذلك فاذا عملت محلة البادهنج كما تقدم فمد خطا من نقطة المشرق الى ضعف سعة مشرق الجدي وهو الموضع المسدود ثم مد خطا من نقطة المغرب الى ضعف سعة مغرب السرطان وهو الموضع المفتوح فكان جملة عدد الهوا الطياب من قسمة الدائرة قفج درجة والهوا المفسود من قسمة تلك الدائرة رز درج ثم قسمنا احد هذا الخطين من طول محلة البادهنج فكان الربع من محلة البادهنج فاعلم ان محلته هي طوله والموضع المفتوح هو عرضه من جهة المغرب والمسدود هو عرضه من جهة المشرق وان شئت من جهة الحساب فانسب عرضه من طوله وتاخذ جيب سعة احد المنقلبين في ذلك العرض وهو كز مد في عرض ل حفظناه ثم زدنا سعة المشرق وهي كز ل دقيقة على ص فما جمع قيز ل دقيقة اسقطنا من ذلك ضعف سعة المشرق وهو نه الباقي سب ل دقيقة اخذنا جيبها فكان نج نج دقيقة اضعفناها فكان قو لو قسمنا عليها المحفوظ فحصل ❊ يه لح ثانية وهو ربع الطول وربع قيراط الطول محبورا فتقسم محلة البادهنج باربعة وعشرين قسما متساوية وتاخذ من تلك القسمة ست قراريط وربع قيراط فهو عرض البادهنج ولم اطلع على هذه الطريقة ممن تقدم من الفضلاء ولا اعلم احدا ذكرها فمن اراد التحرير في ذلك فليفعل ذلك كما بيناه وشرحنا فافهم تصب

"The 91st chapter on knowing how to set up the *maḥilla* of the *bādahanj* and the names of the (various kinds) and the amounts (measured) on the horizon circle for that latitude which are (open) to favourable winds and (closed) to unfavourable winds.

"The names of the four (kinds of *bādahanj*) are *furātī*, *mujannaḥ*, *killī*, and *ʿādilī*. The *furātī* (literally, having to do with the Euphrates) is the one which stands on the flat surface (*al-qā'im ʿalà saṭḥ mustaqīm*). The *mujannaḥ* (literally, winged) is the one which stands on a surface, "winged" like the wings of a bird (*qā'im ʿalà saṭḥ mujannaḥ* [*sic*, perhaps read *mujannaḥ*[an]] *ka-ajniḥat al-ṭayr*). The *killī* (that is, like a veil) is (read: has?) the sloping surface (*al-saṭḥ al- mā'il*). The *ʿādilī* is the one which is by the side of a wall (*yakūn bi-janb ḥā'iṭ*). If you want to set up (the *bādahanj*), draw a full circle and divide it into four parts (by marking the cardinal directions). Then draw a line from (the point corresponding to) the rising amplitude of Capricorn to (the point corresponding to) the setting amplitude of Cancer (that is, from winter sunrise to summer sunset) in that locality. This will be the *maḥilla* of the *bādahanj* [in] localities which are far from the sea. [For localities which are on the sea] such as Alexandria, Damietta, ʿAydhāb, Jedda and similar places [the *maḥilla* of the *bādahanj* is to be facing the sea]. [*N.b*. The text is corrupt here.] When you have made the *maḥilla* of the *bādahanj* as I have described, draw a

line from the east point to twice the rising amplitude of Capricorn and this will be the closed part (*al-mawḍiʿ al-masdūd*); then draw a line from the west point to twice the setting amplitude of Cancer and this will be the open part (*al-mawḍiʿ al-maftūḥ*). The total number of degrees on the (horizon) circle corresponding to the favourable winds is 183° [*sic*, read 153°] and the number of degrees on the circle corresponding to the unfavourable winds is 207°. Then we divide one of these two lines [which are perpendicular to] (text has: *min*) the length of the *maḥilla* of the *bādahanj* [into two parts] and it will be one quarter of the *maḥilla* of the *bādahanj*. You should know that the *maḥilla* is the length (of the *bādahanj*) and the open part is its width on the western side and the closed (part) is its width on the eastern side. If you want to do this by calculation, take the ratio of its width to its length. (Then) find the Sine of the rising/setting amplitude at either of the solstices at that latitude, which is 27;44 [*sic*, the accurately calculated value is 27;42] at latitude 30°, which we keep in mind. Then we add the rising amplitude which is 27°30′ to 90° to obtain 117°30′ and subtract from that twice the rising amplitude which is 55° and the remainder is 62°30′. We take the Sine of this, namely, 53;13 [the text has 53;53, a scribal error], double it and obtain 106;26. We divide this by the quantity which we kept in mind and obtain 0;15,38, which is a quarter of the length and, when rounded (to 0;15), equals a quarter of a *qīrāṭ* if the length is taken as one *qīrāṭ* (?). Then we divide the *maḥilla* of the *bādahanj* in 24 equal parts and take from this division six and a quarter *qīrāṭ*s which will be the width of the *bādahanj*. I have not seen this method in (the writings of) any of the virtuous scholars who preceded me and I know of no-one who mentioned it. Whoever wants to do this properly let him do it as I have explained. Understand this and you will get it right."

Najm al-Dīn does not deserve top marks for his mathematical presentation. The calculations he presents in such detail are basically absurd but his whole treatise on instruments is not a normal medieval Arabic scientific text. As usual, the calculations are marred by copyists' mistakes. The symbol ❈ used in my version of the Arabic text stands for

ᓂ, which is one of the forms of zero in medieval Arabic *abjad* notation.[863] The essence of his main calculation is to determine the breadth B in terms of the length L using $B = \frac{1}{2} L \tan a$, where a is the solstitial rising amplitude, correctly stated as being equal to 27°30′ for the latitude of Cairo. The base advocated by Najm al-Dīn is only half the width of that described in the Ambrosiana treatise attributed to Ibn Yūnus. The two angles to which he ascribes values of 153° (= 180° - 27°) and 207° (= 180° + 27°) relate to the open and closed parts of the *bādahanj*, and imply that the western side of the device be open to the winds, which is also indicated on his diagram – compare **Pls. S5 & S7**. His directions appear to accord with a wind scheme different from that underlying the Ambrosiana text attributed to Ibn Yūnus (see above). In view of the fact that the part of his text dealing with the different kinds of wind-catchers is garbled, I assume that for this he was merely quoting an earlier source. That same source is quoted by a later writer (see Ibn al-Qāṣiḥ below).

The information provided by Najm al-Dīn on the four different varieties of *bādahanj* is not known to me from other sources besides the related one referred to below, and should be of interest to scholars concerned with vernacular architecture and its transmission if they can understand it better than I can.

Ibn al-Qāṣiḥ

Another source relating to the *bādahanj* is a treatise on the use of the astrolabic quadrant by a scholar in Cairo named Ibn al-Qāṣiḥ (1316-1399), originally from Baghdad and otherwise known for his writings on the Qur'ānic sciences.[864] This treatise exists in three manuscripts of which I

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863 Irani, "Arabic numeral forms" (1956), p. 11-12/720-721.

864 On Ibn al-Qāṣiḥ see Brockelmann, *GAL*, II, p. 214 & SII, p. 212, *etc*.; *Cairo Survey* (1986), no. C51; Rosenfeld & İhsanoğlu, *Mathematicians, astronomers and other scholars of Islamic Civilisation* (2003), p. 259, no. 769. His discussion is

have used MS Cairo Dār al-Kutub *mīqāt* 26, copied about the time of the death of the author. Chapter 63 (fol. 22v-23r) deals with the setting up of *miḥrāb*s and *bādahanj*es (in the manuscript the singular is given as both *bādahanj* and *bādhahanj* and the plural as *al-bawādahanj*), and gives information on the different kinds of *bādahanj*es that were used, as well as their shape – see **Pl. S8**. Part of the text bears marked resemblance to that of Najm al-Dīn, and it seems that both were quoting a common source. The relevant section of Ibn Qāṣiḥ's treatise reads as follows:

الباب الثالث والستون في معرفة نصب المحاريب والبوادهنج ... ... نصب الباداهنج فطريقه ان تخط الجهات الاربع في بلاطة كما تقدم وتبعد عن نقطة المشرق الى جهة الجنوب بقدر سمت البادهنج في ذلك البلد من اجزا قوس الارتفاع وتعلم في قوس الارتفاع علامة ثم تضع المسطرةعلى مركز الربع وعلي تلك العلامة ثم تخط خطا في البلاطةعلى حرف المسطرة فيكون ذلك الخط هو سمت البادهنج وهو موضع المَحِلَّة والبادهنج على انواع فراتي وهو الذي قايم على سطح مستقيم ومجنح وهو الذي قايم على سطح كاجنحة الطير وعادلي وهو الذي يكون بجنب حائط وكلي وهو الذي هو مايل السطح وان كانت البلدة التي تضع فيها البادهنج على سواحل البحر المالح كالاسكندرية ودمياط ونحو ذلك فان محلة البادهنج مستقبلة البحر فاذا عملت محلة البادهنج فمد خطا من نقطة مشرق الاعتدالين الى ضعف سعة مشرق الجدي وهو الموضع المسدود ثم تمد خطا من نقطة المغرب الى ضعف سعة مغرب السرطان وهو الموضع المفتوح فكان جملة المطلوب من قسمة دايرة الافق قنج درجة والهوا المفسود رز درجات فاذا قسمنا احد هذه الجوانب من طول محلة البادهنج فكان الربع منها فتعلم ان محلة البادهنج هي طوله وعرضه هو ربع طوله واعلم ان سمت البادهنج بمصر كز درجة مه دقيقة وسمت القبلة بمصر لز وقيل لز ل لان عرض مكة اختلف فيه فقيل كا وقيل كا ل وقيل غير ذلك انتهى واختلف في عرض مصر فقيل ل وقيل كط نه وطوله نه وطول مكة سز وقيل غير ذلك وان مصر في الربع الغربي الشمالي ومكة في الربع الشرقي الجنوبي انتهى وان اهل مصر وسكدرية الى القيروان الى تاهرت والسوس الاقصى الى البحر الاسود وما كان على سمت ذلك من البلاد يستقبلون في صلاتهم من ركن الكعبة الغربي الى ميزابها وقد ذكرت الاستدلالات على جهات الكعبة بمهبات الرياح الاربع في تصنيف لطيف

"The way to set up the *bādahanj* is to draw the four cardinal directions on a flat slab (*balāṭa*) as described above, and move from the east point towards the south by the amount of the azimuth of the *bādahanj* in that locality by (using) the degrees of the altitude arc. You make a mark on the

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featured already in King, "Architecture and astronomy" (1984), p. 111 / *Synchrony*, vol. 1 (2004), VIIb: 799-800, and the references there cited.

altitude arc (of the quadrant), then you place the ruler on the centre of the quadrant and on the mark and draw a line on the slab through the end of the ruler: the line will be the azimuth of the *bādahanj*, which is the position of the ***maḥilla* [vowelled thus in the text]**. There are (different) kinds of *bādahanj*s: (1) *furātī*, which stands on a straight surface (*qā'im ʿalà saṭḥ mustaqīm*); (2) *mujannaḥ*, which stands on a surface like the wings of a bird (*qā'im ʿalà saṭḥ ka-ajniḥat al-ṭayr*); (3) *ʿādilī*, which is by the side of a wall (*yakūn bi-janb ḥā'iṭ*); and (4) *killī*, which has a sloping surface (*wa-huwa mā'il al-saṭḥ*).

"If the place where you put the *bādahanj* is on the shores of the sea, like Alexandria or Damietta or somewhere similar, the *maḥilla* of the *bādahanj* is to be facing the sea. If you have made the *maḥilla* or the *bādahanj*, extend a line from the rising point of the equinoxes to twice the rising amplitude of Capricorn which is in the direction of the closed part (of the *bādahanj*) and then extend a line from the west point to twice the setting amplitude of Cancer, which is (the direction of) the open part. The total required angle on the horizon circle is 153°, and the blocked air is 207°. If we divide one of the sides by the length of the *maḥilla*, it will be one-quarter of it. You know that the *maḥilla* of the *bādahanj* is its length, and its width is a quarter of its length.

"Know also that the azimuth of the *bādahanj* in Cairo is 27 degrees and 45 minutes. The azimuth of the *qibla* at Cairo is 37° and it is also said to be 37°30′ because there is a difference of opinion concerning the latitude of Mecca; some say it is 21° and others say 20°30′ or yet other values. There is also a difference of opinion concerning the latitude of Cairo, some say it is 30° and others 29°55′. The longitude of Cairo is 55° and the longitude of Mecca is 67°, but some say other values. Cairo is in the north-west quarter and Mecca is in the south-east quarter. *The inhabitants of Cairo and Alexandria up to Kairouan and Tahert and al-Sūs al-Aqṣà and the Atlantic Ocean, and all places in that azimuth, all face in their prayers the section of the Kaʿba from the western corner to the water-pipe (at the middle of the top of the north-west wall of the Kaʿba).* I have discussed in a short compilation the ways to find the direction of the Kaʿba by the blowing of the four winds."

Here we see an unusual and particularly interesting mixture of mathematical geography and folk geography, each of which we have discussed above.[865]

Islamic mathematical geography, involving the determination of the *qibla* using geographical coordinates and a mathematical procedure, geometric or trigonometric, constitutes the background of the **text underlined**. I shall not comment upon it here, save to note that a key to understanding it is in a geographical treatise by the Cairene astronomer Ibn al-ʿAṭṭār (*ca*. 1430), in which similar information is presented.[866]

Islamic folk or sacred geography on the other hand involves the notion of the world divided in sectors around particular divisions of the perimeter of the Kaʿba and it constitutes the background of the ***text italicized***. Unfortunately, Ibn Qāṣiḥ's short treatise on the *qibla* promised at the end of this extract is not preserved in the known manuscript sources, although various other treatises dealing with the *qibla* from a folk scientific point of view do survive. In such treatises, dating from the 9th century onwards, different geographical areas are associated with specific sections of the perimeter of the Kaʿba – see above – and Ibn al-Qāṣiḥ follows this tradition. None of the treatises on the *dalā'il al-qibla* currently known to me broaches the orientation of the *bādahanj*. Various Egyptian treatises on sacred geography have been studied, with which Ibn Qāṣiḥ's pronouncements can be placed in context.

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865 On Ibn al-Qāṣiḥ's writings on sacred geography in context see King, "Islamic sacred geography and finding the *qibla* by the sun and stars" (2019), no. 22.

It was in the Yemen that the two traditions were practiced side by side, sometimes both by the same astronomer: see King, *Mathematical astronomy in medieval Yemen* (1983), and Schmidl, *Volkstümliche Astronomie im islamischen Mittelalte*r (2007).

866 King, "Mathematical geography in 15th-century Egypt" (2008), esp. pp. 16-17. On medieval measurements of the latitude of Mecca see *idem*, "The first Islamic geodetic measurements" (2000), pp. 225-228.

Ibn al-Qāṣiḥ states that the azimuth of the *bādahanj* is 27°45′ S of E. This value is either based on the solar rising amplitude at the solstice, namely, 27°30′, with 0°15′ added to take care of the apparent solar radius and thus to represent the azimuth of the right-hand (southern) edge of the solar disc as it rises at midwinter, *un vrai excès de délicatesse*, or it is an error for the 27;44 given as the Sine of the solar rising amplitude by Najm al-Dīn al-Miṣrī. Ibn al-Qāṣiḥ's remarks about setting up the *bādahanj* on the *maḥilla* are as verbose and as obscure as those of Najm al-Dīn.

Ibn al-Majdī

Another source for us to consider is the short treatise entitled تحفة الاحباب في نصب الباداهنج والمحراب, *Tuḥfat al-aḥbāb fī naṣb al-bādāhanj wa-'l-miḥrāb*, "The gift of the loved ones on setting up the *bādahanj* and *miḥrāb*", by Ibn al-Majdī (1366-1447), the leading Egyptian astronomer of his time.[867] Ibn al-Majdī was a *muwaqqit* at the al-Azhar Mosque and head teacher at the Jānibakiyya Madrasa, a privately-endowed religious college. This treatise of his survives in several copies, of which I have used MS Cairo Dār al-Kutub *mīqāt* 183,2, fols. 7r-11r, copied *ca*. 1450. Another copy is MS Cairo J 3964,17, completed in 1458, and there are four later manuscripts in Cairo. (On the Berlin copy see further below.) Two other copies that I have not seen are MSS Cairo *ʿaqā'id* 3964/17 and Tehran Majlis 3572/10.

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867 On Ibn al-Majdī see *Cairo Survey* (1986), no. C62 (esp. 3.3.7), and the article "Ibn al-Majdī" by François Charette in *BEA*. On his life and contacts see especially Brentjes, "Shams al-Dīn al-Sakhāwī on muwaqqits, mu'adhdhins, and the teachers of various astronomical disciplines in Mamluk cities in the 15th century" (2008).

On manuscripts of his works see, in addition to *Cairo Survey*: Rosenfeld & İhsanoğlu, *Mathematicians, astronomers and other scholars of Islamic Civilisation* (2003), p. 277, no. 815, esp. item A13. He seems to have had a passion for ephemerides, and he prepared some auxiliary tables for compiling them without using the tables of mean motions and equations that were standard in *zīj*es: see n. 579.

The treatise is devoted only to methods for marking the azimuth of the *bādahanj* at 27½° S of E and the *qibla* at 37° S of E on a plane horizontal surface:

> وبعد فهذه رسالة لطيفة سميتها بتحفة الاحباب في نصب الباداهنج والمحراب نذكر ذلك في عرض مخصوص ويقاس غيره عليه فنقول اعلم ان سمت القبلة بمدينة مصر حماها الله على سبعة وثلاثين درجة وسمت الباداهنج سبعة وعشرين ونصف وكلاهما في الربع الشرقي الجنوبي ...

> "This is a short treatise which I entitled "The gift of the loved ones on setting up the *bādāhanj* and *miḥrāb*". We shall mention this subject for a specific latitude and for other latitudes things can be done essentially the same way, adjusting for the latitude and for the local *qibla*. Know that in the city of Cairo – may God protect it – the azimuth of the *qibla* is thirty-seven degrees and the azimuth of the *bādāhanj* is twenty-seven and a half degrees, both being in the south-east quadrant. … "

Ibn al-Majdī might be thought to be exaggerating a little when he suggests carrying out these procedures for other latitudes (my translation is very free); it would be very interesting to known which localities he had in mind. Very rarely have we encountered evidence of *bādahanj*es in towns of the Nile Valley or Delta or Red Sea coast – **Pls. C15 & E8**. For coastal towns, especially Alexandria, I can attest from many months' experience in summer and in winter that any *bādahanj* would need to be closed up when necessary (اذا احتيج يسد). One 18th-century image of supposed wind-catchers in Alexandria turned out to be deceptive – **Pls. E2-E3**.

In passing, we note that the German physicist and historian of Islamic science Eilhard Wiedemann (1852-1928), in a series of studies on Islamic astronomical instruments, introduced the treatise of Ibn al-Majdī, having consulted MS Berlin Deutsche Staatsbibliothek Ahlwardt 5690, copied in 1433.[868] However, he mistakenly thought the text dealt with some kind of sundial but wisely did not translate the word *bā<u>dh</u>ahanj*. In a later study

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868 Wiedemann, *Aufsätze zur arabischen Wissenschaftsgeschichte* (1970 reprint), vol. 1, p. 546, and n. 1 on p. 589. On the Berlin manuscript see Ahlwardt, *Verzeichniss der arabischen Handschriften* (1893), p. 170.

he rendered it as “Schornstein”, that is, “chimney”, which is actually rather close to the truth! The celebrated German orientalist Wilhelm Ahlwardt (1828-1909), who in 1893 had catalogued this manuscript (and hundreds upon hundreds of others) had wisely refrained from an interpretation of the curious word.

Ahlwardt was one of the greatest orientalists of the 19th century. When I was a graduate student, I photocopied the volume of his catalogue dealing with astronomy and mathematics. Whilst cataloguing the Cairo scientific manuscripts, on a very different level, I always envied Ahlwardt, who had the manuscripts he catalogued brought to his home by stage-coach.

al-Bilbaysī

The only astronomical source currently known to me which actually identifies the *qibla* as 27° S of E for Cairo and the orientation of the *bādahanj* as winter sunrise “for your locality”, which would also be at about 27° S of E for Cairo, is a treatise on the use of the astrolabic quadrant by Zakariyā ibn Yaḥyà al-Bilbaysī, an Egyptian astronomer of the 14th or 15th century. This survives in MS Cairo Ṭalʿat *majāmīʿ* 377,3, fols. 20v-21r:[869]

> ... وقد تحددت لك الجهات الاربع فاذا خرجت لك الجهات الاربع فعد من قوس الارتفاع بقدر سمت القبلة وهو سبعة وعشرون درجة في مصر او بقدر سمت الباداهنج وهو مثل سعة المشرق لبلدك طالبا الجنوب وضع الخيط عليه يكون سوا كان جهة القبلة او جهة الباداهنج ثمة الجهة المطلوبة
>
> “ … when you have found the four cardinal directions count on the altitude scale (of the quadrant) by the amount of the azimuth of the *qibla* which is twenty-seven degrees in Cairo, or by the amount of the azimuth of the *bādāhanj* which is the (maximum) solar rising amplitude for your locality, moving towards the south. Then put the thread (which is attached at the ‘centre’ of the quadrant) on whichever it be – azimuth of the *qibla* or

869 On al-Bilbaysī see *Cairo Survey* (1986), no. C64.

azimuth of the *bādāhanj* – and that will be the required direction."

This text is of especial interest because it is written by an astronomer who is proposing the *qiblat al-ṣaḥāba* at 27° S of E rather than the *qibla* of the astronomers at 37° S of E. Again, modifying the azimuth of the *bādāhanj* for a latitude other than 30° for Cairo is an *excès de délicatesse*, especially when our author is talking about two directions that for Cairo are less than one degree apart.

al-Fāraskūrī

Another reference of the same kind is found in a treatise on the use of the trigonometric sine quadrant by an unidentified author named Muḥammad Ḥattāta al-Fāraskūrī, who apparently died in 1053 Hijra (1643/44).[870] The unique copy of this treatise, MS Cairo Dār al-Kutub *mīqāt* 639,5, was penned *ca*. 1700, and the section relating to our subject (fol. 50r) reads as follows:

> الباب الثاني عشر في معرفة سمت البادهنج اعرف سعة المشرق على مدار الجدي لسمت مكة ثم ابعد بقدره في الجنوب فما كان فهو سمت البادهنج والله اعلم ...
>
> "The twelfth chapter: on finding the azimuth of the *bādahanj*. Find the rising amplitude of the day-circle of (the sun at the beginning of) Capricorn for (??) the azimuth of Mecca, and then move south by this amount (from the east point): this will be the azimuth of the *bādahanj*. God knows better."

It seems improbable that our author is, out of the blue, proposing orienting a wind-catcher for Mecca; this would necessitate the words لعرض مكة, *li-ʿarḍ Makka*, "for the latitude of Mecca". A copyist's error of مكة, Mecca, for مصر, Cairo, is not conceivable. Rather, it seems that al-Fāriskūrī is

870 On al-Fāraskūrī see *Cairo Survey* (1986), no. D181.

trying to say that the direction of winter sunrise is the azimuth of Mecca, which it is it if one is talking about the *qiblat al-ṣaḥāba*.

al-Minūfī

Around the year 1600 a new corpus of tables for timekeeping was compiled by Shams al-Dīn al-Minūfī,[871] using an updated value of the obliquity of the ecliptic. This still contained a table for orienting the *bādahanj* in the direction of winter sunrise. The original corpus of tables for time-keeping attributed to Ibn Yūnus, and to a lesser extent the new tables of al-Minūfī, were used in Cairo until the 19th century.

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Now we have seen from medieval Arabic historical and literary sources that wind-catchers used to be an integral part of the Cairo skyline, and we know from the medieval Egyptian astronomical literature that they were astronomically aligned. The axis at the bottom of the opening toward roughly NNE was laid out perpendicular to winter sunrise at roughly ESE, in conformity with the local wind-schemes and with the roughly orthogonal street-plan of Fatimid Cairo. From this it followed that the rectangular *cardo* (orthogonal street-plan) of Fatimid Cairo was laid out with its minor axis toward winter sunrise. But Fatimid Cairo was laid out alongside the Red Sea Canal, which, as luck would have it, was conveniently straight at that location for hydrological reasons and by sheer chance lay perpendicular to winter sunrise. It was not by chance that the new city was laid out along this stretch of canal, but it was certainly most fortunate that that stretch was perpendicular to the *qiblat al-ṣaḥāba*.[872]

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[871] On al-Minūfī see *Cairo Survey* (1986), no. C120. On his new tables see *Synchrony*, vol. 1 (2004), II: 318-320.

[872] Jonathan Bloom appears to be the first historian of Islamic architecture to recognize the potential significance of the orientation of the Canal. See n. 773 above.

20 — Medieval Cairo – a city facing the Kaʿba

> “To my knowledge, no study of the orientation of Egyptian mosques has ever been conducted.” DAK, *The astronomical works of Ibn Yūnus* (1972), p. 256. (Nothing has changed.)

> “But the history of Cairene architecture still awaits a critical treatment that presents architecture as a product of culture, history and environment, that pursues explanations of historical phenomena beyond set boundaries, and that challenges the discipline of architectural history to integrate what has been left out in the continuous project of rewriting the history of architecture.” Nasser Rabbat, “Writing the History of Islamic Architecture of Cairo” (1994), p. 145 of the reprint.

> “Old mosques were most probably built oriented to the qibla using the methods available at the time.” Mohamed Zakariya, the renowned American Muslim calligrapher, in his essay “The trouble with the qibla”. (The words “most probably” are actually superfluous.)

> “Have you ever prayed in the *qibla*? If not, then you know nothing about the *qibla*.” Question, and answer, addressed to me by a Muslim dignitary after a lecture of mine in Istanbul in July, 1983, on the newly-discovered sources relating to the sacred geography of Islam.

> کعبه ان سنگ بنائي است که ره گم نشود . “The Kaʿba is only a cornerstone, a sign to show the road.” Ali Shariati (1933-1977).

The wind-catchers that graced many of the roofs of religious and domestic architecture in medieval Cairo have revealed their secrets. Our investigation into these devices developed into a study of orientations in medieval Cairo and even provided new understanding of the layout of the

medieval city. But it comes at a time when people can publish entire books on Islamic architecture without even mentioning the *qibla*.[873]

We have shown first that the orientation of the Fatimid city of al-Qāhira, determined by the local orientation of the renewed Pharaonic/Roman Red Sea Canal, which was necessarily determined by topography, was fortuitously perpendicular to the direction taken as the *qiblat al-ṣaḥāba*, that is, winter sunrise. Second, that the various orientations of mosques in medieval Cairo were all expressions of a desire to have the mosques facing the Kaʿba. The orientation of the *bādahanj*es of medieval Cairo, as described in the medieval astronomical sources, namely, open toward the direction perpendicular to winter sunrise, provided the clue to these revelations.

It remains something of a mystery why the Egyptians called the *qibla* toward winter sunset the *qiblat al-ṣaḥāba* when the mosque of the Companions of the Prophet in Fustat was built towards the east. It was, as we have seen, some 70 years later that the Mosque was rebuilt in the "new" *qibla* toward winter sunrise. And what other sources on the *qibla* and the orientation of medieval mosques are available that have not yet been exploited for relevant information? We do even have an indexed translation of al-Maqrīzī's *Khiṭaṭ*, and there are many more Egyptian historical works that we have not consulted. A scholarly production on the splendid treatise of the legal scholar al-Dimyāṭī is rather urgently needed, as well as a survey of the internal/external orientations of historical mosques and madrasas and mausolea in the context of the surrounding street-pattern, if this is original.

The celebrated Muslim calligrapher Mohamed Zakariya was "right on" with his remark about historical mosques being oriented "using the

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[873] To mention just one example out of many: Hisham Mortada, *Traditional Islamic Principles of Built Environment* (2003).

methods available at the time". We discussed these matters both in New York and Washington in the early 1980s, and both us put pen to paper.

To assist those young people interested in the way in which Muslims have determined the sacred direction over the centuries I recommend a new bibliography of some 150-odd reliable books, articles and websites.[874] Colleagues in the history of Islamic architecture would do well to read some of this material before continuing to write such comments as "this mosque is incorrectly aligned toward Mecca" or "that mosque is falsely aligned". As far as mosque orientations are concerned, it's about 'them', not about 'us', and if we know nothing about the *qibla*s they used, then we should not pronounce on the orientations of their mosques. Meanwhile we have modern scientists rediscovering the mathematics behind *qibla* determinations for a non-spherical earth and coming to conclusions which sound like proclamations by early legal scholars.[875]

Althought most historians of Islamic architecture seem to be disinterested or overwhelmed by the problem of orientations, some are alert to the problems posed by the architecture itself and to the explanations provided by medieval texts and to the fact that similar palettes of diverse *qibla*-directions are found from one end of the Islamic world to the other.[876]

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874 King, "Bibliography on historical *qibla* determinations" (2018).

875 Tono Saksono & Mohamad Ali Fulazzaky & Zamah Sari, "Geodetic anaysis of disputed accurate *qibla* direction" (2018), p. 137:

> "It is impossible for Muslims to face towards the correct direction of *qibla* during the five daily prayers unless they perform the prayers in front of the Kaaba."

876 It is pleasing to see several new studies by Islamicists, historians of Islamic architecture, and physicists, all of whom do know about historical *qibla* determinations. I think of Fabrizio Anticoli, "Some remarks on the appearance of the mosque: the introduction of the niche-*miḥrāb* and the change of the *qibla*" (2020); Michelina Di Cesare, "A *qibla musharriqa* for the first al-Aqṣā mosque?" (2017) and "Orientamento della prima fase della moschea al-Aqṣā di Gerusalemme" (2017); and Mustafa Yilmaz & Ibrahim Tiryakioglu, "The astronomical orientation of the

I hope that the reader can now see the way in which Cairo is a city facing the Kaʿba. It does not matter that some of its religious architecture actually faces this way, and some of it faces that way. All of this architecture was intended to face the Kaʿba. **It is not just specific religious complexes that are "Mecca-oriented"; they are all "Mecca-oriented".** And we should keep in mind that the *qibla* is not toward Mecca, but toward the Kaʿba. The idea that Cairo faces the Kaʿba in different ways is not new (see **Pls. T3 & U9**), but it has perhaps not been clearly stated enough in modern times.

It is more important that those who discover that historical mosques are not aligned in the modern direction of Mecca realize that these mosques might indeed be aligned in the *qibla* directions that were accepted in that place at that time. If they know nothing about medieval *qibla* determinations (or about Islam), they are hardly qualified to pronounce on the reasons behind these mosque orientations. Not only those who to show that historical mosques are deliberately not aligned to Mecca risk making fools of themselves.[877] This is, alas, also the case of both archaeologists

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historical Grand Mosques in Anatolia (Turkey)" (2018). I am confident that there are more that have not come to my attention.

877 Dan Gibson, *Early Islamic Qiblas* ... (2017); King, "The Petra fallacy ... " (2018), at www.academia.edu/37957366/.

A. J. Deus, "Monuments of Jihad – The thought process of determining qibla orientations by Turks", at www.academia.edu/37688323/ (2018); King, "The Ottoman mosque fallacy ... " (2018), at www.academia.edu/37957500/.

and reporters involved with two ‘new’ mosques announced in 2019, one in the Negev,[878] and the other near Madrid.[879]

In the words of George Sarton (1884-1956),[880] the celebrated Belgian-born historian of science who was one of the first non-orientalist Westerners in modern times to appreciate the Muslim contributions to science:[881]

> “The past cannot be separated from the present without grievous loss. The present without the past is insipid and meaningless; ... .”

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878 Amanda Borschel-Dan, “One of the earliest mosques in the Holy Land unearthed in Bedouin city of Rahat” (18.07.2019), at www.timesofisrael.com/one-of-the-earliest-mosques-in-the-holy-land-unearthed-in-bedouin-city-of-rahat/; “1200 year-old mosque uncovered in Bedouin city in Southern Israel” by JP staff (18.07.2019) at www.jpost.com/Israel-News/1200-year-old-mosque-uncovered-in-Bedouin-city-in-southern-Israel-596063; Anonymous, “Israel mosque find: Archaeologists unearth 1,200-year-old ruins in desert” (18.07.2019) at www.bbc.com/news/world-middle-east-49036815; and “The early Israeli Mosque isn’t Early – BBC gets it wrong!”, https://mail.google.com/m—*—ail/u/1/#inbox/FMfcgxwDqfDKcTBtqJkBBWpvVtprSzlf?projector=1.

879 Joachim Henning & Michael McCormick & Lauro Olmo Enciso & Knut Rassmann & Eyub Fikrit Eyub, “Reccopolis revealed: the first geomagnetic mapping of the early medieval Visigothic royal town”, *Antiquity* 93: 369 (12.06.2019): 735-751, and Megan Gannon, “Europe’s oldest mosque may be buried underground in this Visigothic city”, *Live Science* 20.06.2019, www.livescience.com/amp/65760-visigoth-reccopolis-city-revealed.html?__twitter_impression=true.

880 www.the-scientist.com/commentary/how-an-understanding-of-science-history-is-useful-enriching-and-rewarding-59516. On Sarton’s contributions to our subject see Hossam Elkhadem, “George Sarton: Historian of medieval Islamic science”, at www.sartonchair.ugent.be/file/160.

881 He did this by studying mainly what orientalist scholars writing in French (19th century) and in German (early 20th century) had written about the subject and he also ventured into a few libraries to have a look at some oriental manuscripts, activities that can still be highly recommended.

Sarton stated this in 1955 about civilization in general and science in particular, but his remark certainly also holds for the ubiquitous and charming wind-catchers of medieval Cairo. Worse could be said about the ubiquitous and horrendous air-conditioners of today – **Pls. W1-W2**.[882] And it so happens that George Sarton in 1933 was the first to raise the question in the scholarly literature about the often curious orientation of historical mosques, for which nobody at the time knew the explanation.[883] We have come some way since then, but only by consulting medieval Arabic texts which cast substantial light on the situation.

And for the future ...

> "One of the fundamental flaws of our civilisation is its inability to think outside the present." Andri Snær Magnason, Icelandic glaciologist, quoted in "The glaciers of Iceland seemed eternal. Now a country mourns their loss", *The Guardian* 14.08.2019 – see **Pl. W8**.

> **"**A traditional Arabic form of architecture could be a solution to the huge energy usage for air conditioning in hot countries, according to a UK-based design academic. The wind tower – a fixture of Middle Eastern architecture for almost 1,000 years – could provide 21st century sustainable construction solutions, said Ben Hughes, associate professor of building physics at Leeds University." Nick

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882 See Susan Roaf, "Air-conditioning avoidance: lessons from the windcatchers of Yazd" (2005).

For a photo of this author freezing even though wearing a heavy scarf inside one of the buildings of the University of Sharjah in the United Arab Emirates see **Pl. W1**.

883 Sarton, "Query: Orientation of the mihrab in mosques" (1933), *etc*., with various replies from colleagues in the history of Islamic architecture, history of Islamic urban development, and the history of science, who, like Sarton, did not know the answer.

Ames, "Wind towers stage a comeback", *Middle East Architect* 30.01.2014.

"Extreme events linked to climate change, such as the heatwave in Europe this year (2019), are occurring sooner than expected, an ex-chief scientist says. Prof Sir David King says he's been scared by the number of extreme events, and he called for the UK to advance its climate targets by 10 years." Roger Harrabin, "Faster pace of climate change is 'scary', former chief scientist says", BBC, 16.09.2019 – **Pl. W6**.

"To realise that our knowledge is ignorance,
This is a noble insight.
To regard our ignorance as knowledge,
This is mental sickness."
From the *Too Teh Ching*
(traditionally credited to the 6th-century Chinese sage Laozi).

"Time present and time past
Are both perhaps present in time future,
And time future contained in time past. ... "
T. S. Elliot (1888-1965).

For the future I would advise anybody seriously interested in the *bādahanj*es of medieval Cairo to consult in addition to the present study the following ones:

Lézine 1971 —Rosenthal 1977 — King 1984 — Jaubert 1995 —

Daniel 2010 — Lamees 2014 (?)* — Masarwa 2017

(* I have not seen this yet.)

There is certainly more research to be done on the *bādahanj*es of medieval Cairo:

- further investigation of Ancient Egyptian origin / Iranian immigrant origins / Iranian origin *via* Iraq and Syria;
- proper documentation of all literary references in medieval Arabic historical sources;

- continued investigation of the poetry on the *bādahanj* in both medieval anthologies;
- reinvestigation of the relevant astronomical sources;
- proper documentation of relevant European travellers' reports;
- consideration of the orientation of existing wind-scoops and ventilation-shafts; and
- a proper pictorial *répertoire* of relevant images and photographs.

In the wider context, the situation in medieval al-ʿIrāq and Syria should be investigated in light of the situation in Iran.

The medieval situation should not be confused with the modern one. The bibliography of the vast number of works by engineers of one sort or another on wind-catchers and wind-towers **(Section IX)** illustrates that most had little or no idea about their history or their geographical proliferation. The Iranian authors are the best informed. Some writers seem to mistakenly think that these devices originated on the West coast of the Gulf.

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There is more to be done on medieval Egyptian written sources on the *qibla* in Egypt. In particular**, there is some urgency for somebody to work on the discussions of the *qibla* and mosque orientation by Ibn Duqmāq and al-Maqrīzī**. (It is a sad reflection on our field that there is not yet any translation of this great work.) As noted above, **al-Dimyāṭī's unpublished writings on this subject are even more important from a historical point of view than those of al-Maqrīzī but are less readily available**. The impending danger is that some crank starts to interpret the Cairo orientations for themselves and finds they are not facing the modern direction of Mecca at all, and says this study of mine is nonsense.

And there is more to be done on orientations in medieval Cairene religious architecture, perhaps using the useful *catalogue raisonné* of Nicholas Warner where basic information and bibliography are available for hundreds of buildings, each being assigned a number. It is high time to abandon the notions "Mecca-oriented" and "not Mecca-oriented". This was moderately useful before we started to understand what "Mecca-

oriented" in medieval Cairo actually meant. It certainly does not mean that all mosques face the same direction. What somebody should do now is:

- measure the external orientations of the major monuments (and internal ones, if different);
- arrange them and group them according to location, date, orientation;
- consider them in their medieval urban context, if possible;
- review the role of the Red Sea Canal / al-Khalīj and its orientation;
- investigate the orientations in the light of what we know from medieval written sources.

(Such an undertaking can be carried out using Google Maps; one does not have to be on-scene.) The results might surprise many people, as is often the case with historical enquiries conducted for the first time.

For the future, I would also advise anybody working on historical Islamic architecture to keep in mind that its orientation is as important as any other feature such as domes, minarets, minbars and mihrabs, although these are perhaps easier to understand. For Muslims, of course, the orientation toward the Kaʿba is the most important feature of any mosque or religious edifice.

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With these words I express the hope that the reader will have understood how the *bādahanj*es, veritable icons of the medieval City Victorious, were set up, as the poet said, "turned away from the *qibla*". Was it "for love of air" or "for love of passion"? Certainly the Cairenes were passionate about their wind-catchers. And so they should have been. They exude serenity. They emit pleasing sounds. In their own special way, they are beautiful. They certainly inspired the medieval poets. They are a symbol of man's intelligent and non-destructive appreciation of his environment. But now they're more or less all gone. And without wind-catchers, we'll have only air-conditioners, and without medieval Cairo, we'll have only Masdar City, and maybe worse.

Having said that, there are many other great cities from one end of the Muslim world to the other, whose urban history could be enriched by any historian who had an idea of what the accepted *qibla*-values were centuries ago. Mosques and other religious architecture which to a modern investigator might not appear to face Mecca can be shown to face the Kaʿba in any of several ways that were available at the time they were built. Cairo is just one Muslim city which faces the Kaʿba.

Acknowledgements

It was my wife Patricia who guided me to the splendid wind-catcher of the Musāfirkhāna in the 1970s. Already in those early days she was confronted with my excitement at finding a table for orienting wind-catchers in astronomical directions, and she valiantly tolerated the launching of this new study in the summer of 2019, which stretched into the Year of the Plague. It was Patricia who took the first photos of engravings in the paper-back edition of the *Description de l'Égypte* and who suggested procedures that regenerated failing computers and associated hardware and otherwise sustained the author. We both now agree that "enough is enough" (*genug ist genug*), at least as far as the wind-catchers are concerned.

The Arabic manuscripts in the Egyptian National Library that first aroused my interest in the wind-catchers were investigated during the course of the operation to catalogue the 2,500 scientific manuscripts in the Library collection. Research on the history of Islamic astronomy conducted the American Research Center in Egypt during 1972-79 was generously funded by the Smithsonian Institution Foreign Currency Program. To each of these three institutions my sincere thanks again, even some 50 years later.

It was Erica Dodd of the American University of Beirut who introduced eager groups of AUB faculty and students, including my wife and myself, to the historical architecture of Syria during the academic year 1971-72. Our joint adventures in the Syrian desert have been recounted elsewhere.

To all those scholars of many nationalities who have contributed to the conservation, preservation and documentation of medieval Cairo monuments, we all owe a tremendous debt. One of those was the late Felicitas Jaritz, formerly of the Swiss Institute in Cairo, who was the only scholar in Cairo whom I could interest in the wind-catchers, not least because she was working at the time on endowment documents for various Mamluk religious complexes.

John Rodenbeck, formerly of the American University in Cairo, was the only scholar ever to comment on my 1984 study on the Cairo wind-

catchers. His criticisms and suggestions were addressed in the 2004 version.

The late Gerald Hawkins, formerly of Washington DC, deserves mention here for having noted in the early 1980s from satellite photos that the rectangular base of the Kaʿba is astronomically aligned. Since around the same time I had found these same alignments mentioned in a medieval Arabic manuscript, we decided to publish our conclusions together. Since that time it has become apparent that the entire tradition of Islamic sacred geography depends on this remarkable feature of the physical focal point of Muslim worship. Likewise, this situation goes a long way to explain the often curious orientation of medieval mosques.

Other friends and colleagues provided information and guidance and/or encouragement, including (an asterisk denotes assistance to the 1984 publication): Silvia Armando, Subhi Al-Azzawi, Doris Behrens-Abouseif, Farid Benfeghoul, Robert Dankoff*, Humphrey Davies, the late Michael Dols*, Carl Ehrig-Eggert (who informed me about Jaubert's study in 2004 as I was preparing a revised edition of King 1984), Simone Engel, Anne Espérandieu, Lutfallah Gari, Dimitri Gutas*, Nelly Hanna, Salim al-Hassani, Renata Holod, Louisa Jones, Lise Lander-Moldrop, Norbert Löchter, Meharmah Malik, Eckhard Neubauer, Giles Nicklin, Jeremy Nicklin, Susan Roaf, Raja Sarma, Peter Sheehan, Eleanor Sims, Gina Speirs, John Stobart, Nicholas Warner, Yehia Wazeri, and Gezine Yıldız. Some of these are mentioned in the text *ad loc*. None of them bear any responsibility for any errors contained in this monograph.

In particular, my colleagues Paulina Lewicka, Alev Masarwa, and Lutz Richter-Bernburg, each provided me with some useful references to medieval texts and made pertinent suggestions for which I am profoundly grateful, even though these inevitably kept delaying the completion of this monograph.

Likewise, Alexandra Roy of Sotheby's, London, kindly drew my attention to several significant orientalist paintings which I had overlooked. The loneliness of searching for paintings featuring wind-catchers was

alleviated by the knowledge that a diligent art historian was looking for them elsewhere.

It was a singular pleasure to take up contact with Olivier Jaubert, both of us passionate about the Cairo wind-catchers and more. It would have been even more pleasurable to visit with him some of the surviving *bādahanj*es of Cairo.

In 2017 the Cairo-based German historian of science Karl Galle cited my 1984 paper in a tweet relating to Hasan Fathy and got 11 likes in 2 years, which pleased me enormously.

To Christoph Mauntel my gratitude for inviting me to speak on Islamic sacred geography at the conference "Geography and Religious Knowledge in the Pre-Modern World (1150-1550) held at Tübingen University during 11-12.04.2019. It was whilst listening to the papers on Islamic and medieval European cartography that I noticed that first, all of the speakers talked about the winds, and that second, my own 1984 paper on the wind-catchers of medieval Cairo had gone unnoticed by most historians of Cairene architecture, let alone the wider field of those concerned with environmentally-friendly architecture. So there and then I decided to remedy that situation.

For assistance in accessing relevant literature, I am, once again, grateful to Shefayet Chowdhury. Only with Shefayet's help could I access the literature needed for the present study and read it on my own computer screen. It was he who encouraged me to emerge from my retirement a few years ago, first to counter the new wave of *jāhilī* pronouncements on the *qibla* and mosque orientations, and then to address some of the other rubbish that is appearing on the internet about the history of early Islam, the history of Islamic science, and even the history of such a noble device as the astrolabe. Shefayet was of invaluable assistance to me in gathering the secondary literature behind the fascinating story of the forgotten wind-catchers of medieval Cairo, very relevant to our previous undertakings in that they guide us to the most remarkable example of a Muslim city oriented in different ways toward the Kaʿba. Regrettably I could not

present more of the historical background to some of the episodes, as Shefayet would have wished.

The penultimate draft of this monograph was read through for minor errors of style and repetition by my good friend, Jeremy Nicklin, an ardent follower of the project since its inception. He produced strings of errors to shame me and my Word. For this gallant effort my heartfelt thanks. Of course, major problems remain with my timeless prose, constant repetition, and the organization of the text, all of which are all my own responsibility.

None of the above individuals is in any way responsible for any omissions in this study or errors of interpretation. These are solely my own fault. As as the poet said:

ان تجد عيبا فسد الخللا .

His words are translated at the conclusion of **Part II**. The 200-odd images of wind-catchers presented in **Part II** were largely found on the internet, and the search techniques adopted to locate them with Google must remain a secret.

The author

David A. King is an orientalist who has specialized for over 50 years in the history of astronomy in the Muslim world, a subject which spans over a thousand years from al-Andalus to Ceatral Asia to the Yemen.

Whilst studying mathematics at Cambridge University (1960-63) and then Education at Oxford University (1963-64) he started travelling in the Middle East, learning Arabic, and studying comparative religion.

His first appointment was with the Sudan Government Ministry of Education (1964-67), a venture both challenging and exciting, in which he was immersed in an Arabic-speaking environment. In order to continue in Arabic Studies, he decided to "go medieval" and pursue graduate studies in Near Eastern Languages and Literatures and History of Science at Yale University (1968-72). His doctoral dissertation dealt with the astronomical works of the leading Egyptian astronomer, Ibn Yūnus. He then directed a project based at the American Research Center in Egypt (1972-79) to catalogue the 2,500 scientific manuscripts in the Egyptian National Library and to use Cairo as a base to investigate such manuscripts in libraries around the world.

Thereafter he was Professor of Near Eastern Languages and Literatures at New York University (1979-85) and Professor of History of Science at the Johann Wolfgang Goethe University in Frankfurt (1985-2006), directing one of the two principal research centres in Europe for the study of the history of Islamic astronomy (the other being in Barcelona).

King's research first concentrated on hard-core mathematical aspects of Islamic astronomy, but then moved to the truly Islamic aspects of Islamic astronomy. (So many earlier scholars have been interested solely in the Islamic sources which inspired European science, to the extent that they have overlooked what the Muslims did for themselves for over a thousand years.) His publications deal with all aspects of the history of Islamic mathematical astronomy and non-technical folk astronomy, in particular the previously-undocumented regional schools of Egypt, Syria, the Yemen, the Maghrib and Ottoman Istanbul *ca*. 1500.

One of King's main contributions to Islamic Studies and the History of Science has been the first documentation of the ways in which astronomy was used in Muslim society for the purposes of religion: the regulation of the lunar calendar, the organization of the times of prayer, sacred geography and the notion of the world divided in sectors about the Kaʿba, as well as the determination of the sacred direction and the orientation of religious architecture. Since in medieval Muslim society folk science flourished alongside the hard sciences, these activities did not always produce the results that we moderns might expect.

King's writings on medieval Islamic and European astronomical instruments were the first to treat these as historical documents, worthy of the same respect as manuscripts. The discovery of an Iranian Mecca-centred world-map that shows the *qibla* for any locality, or an Andalusī astrolabe with inscriptions in Hebrew, scholastic Latin and Arabic, let alone a medieval Picard astrolabe that used an undocumented monastic number-notation and which came into the possession of two Humanist scholars, served to bring attention to a very neglected field. His studies also resulted in a catalogue of all astrolabes, Islamic and European, to 1500, now on the internet even though incomplete.

The orientalist publisher Brill of Leiden has produced three large volumes on the sacred direction and world-maps for finding the *qibla* (1999); spherical astronomy and astronomical timekeeping (2004); and astronomical instruments (2005). The British academic publisher Variorum has collected five volumes of reprints entitled: *Islamic mathematical astronomy* (1986/1993); *Islamic astronomical instruments* (1987/1995); *Astronomy in the service of Islam* (1993); *Astrolabes from medieval Europe* (2011); and *Islamic astronomy and geography* (2012).

King has also written on some medieval and Renaissance European topics, indeed, Christian topics, using the same "sources and studies" approach that serves the documentation of the history of science. His first book on a medieval European topic pursued the history of a forgotten number notation used primarily by Cistercian monks in the Middle Ages, especially in monasteries in what is now the border region between Belgium and France. From their appearance as an alphabetical shorthand

on a 4th-century-BCE inscription found on the Acropolis, to their diverse uses in medieval scriptoria and even on a 14th-century astrolabe made in a monastic milieu in Picardy, to their resurgence in 20th-century nationalist propaganda, these ciphers had a history of well over 2,000 years.

Another medieval topic was the widespread cult of the extraordinary crucified bearded virgin saint Wilgefortis, who easily qualifies as the most misunderstood saint in Christian history. King shows that her origins are part of the lively cult of virgin saints in 14th-century Flanders and thus have nothing to do originally with the Byzantine robed Christ in Lucca (known as the Volto Santo), as is widely maintained. Her cult spread all over N. Europe from England and Normandy to Poland and down to Bavaria and the Alpine regions (where she was confused with the Volto Santo) and in some places was still functioning in the early 20th century. This is a prime example of a religious tradition invented to deal with a specific, very serious issue (man's inhumanity to woman), and a cult which spread, flourished for half a millennium, and died out, only to be resurrected in false guise in Gender Studies and on the internet.

A Renaissance adventure started with the Latin epigram in the form of an acrostic that was engraved on a beautiful astrolabe made by the young German astronomer Regiomontanus for his sponsor the Greek Cardinal Bessarion. The dedication is dated Rome, 1462. The astrolabe is the most elegant of a dozen such astrolabes produced by the Vienna school. Now the eight sections of the acrostic formed by its vertical axes can be associated with eight sets of multiple Greek/Roman-style monograms which correspond to the names of the eight persons depicted in the magnificent but enigmatic painting known nowadays as "The Flagellation of Christ", by the 15th-century mathematician and painter Piero della Francesca. The painting originally bore the title *Convenerunt in unum*, a Biblical phrase meaning "they came together in one". The epigram was compiled by the young German man in red for his bearded Greek sponsor, and both of them were united with Piero by a common interest in the higher mathematics of Archimedes. The epigram reveals the multiple identities of the eight persons represented in the painting, in which they

all “come together in one”, as well as the multiple purposes of the ensemble. (In the past 150 years, over 50 attempts have been made to identify these individuals; this is the first that is based on a relevant text. Two of these individuals, the ones who look like a older Greek and a younger German, are Bessarion and Regiomontanus.)

Whilst he has not concentrated on intercultural transmission, he has made an overview of European Renaissance astronomical instrumentation, identifying earlier Islamic examples of the same instruments. The similarity between the two sets is hardly surprising to a historian of astronomy familiar with both traditions. But is it historically significant?

King is since 2019 a life-long citizen of the EU. He lives in retirement between an apartment in inner-city Frankfurt and a farm-house in the Ardèche. All of his publications are available for downloading at www.davidaking.academia.edu.

Notes on the preparation of the text of this monograph

> "It must be said that the manner in which this volume has been written is not immediately appealing. ... It is full of autobiographical material irrelevant to the argument of the book (when and how his computer was repaired, *etc*.). ... ." Emilie Savage-Smith, 2000, review of DAK, *World-Maps* (1999), p. 33.

Many readers have appreciated my previous reports on computer problems associated with the preparation of complicated book-length texts replete with diagrams and footnotes.[884] Here is the latest one. Together they constitute frightening episodes in a continuing horror story.

Text and illustrations were prepared essentially with my right hand, primarily between May, 2019, and June, 2020. (I used to be left-handed for over 70 years, but a series of surgical errors offered a new challenge for my right hand.) The text was typed with two fingers. Given that situation, I did not need the rest of what happened.

All of what I now relate took place to the background of the ever-invasive, all-obtrusive, and very greedy **Adobe Acrobat Reader**, which made using the very useful software **Preview** problematic. With friendly **Preview** one can read pdfs and copy sections of their content. With **Adobe Acrobat Reader**, which somehow installed itself on my computer, one cannot do anything useful without buying more "stuff". Earlier, when handling hundreds of pdf files, **Preview** was far more useful, but it often submits to **Adobe Acrobat Reader** when I try to open it. **Adobe Acrobat Reader** even interferes with the operation of the printer when one is trying to print a file. PDF files which download into **DMS files** on your screen are an even greater curse.

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[884] See *World-Maps for Finding the Direction of Mecca* (1999), pp. xxi, n. 7; *The ciphers of the monks* ... (2001), p. 19, n. 10; *Astrolabes and angels, epigrams and enigmas* ... (2007), p. vi; and *In Synchrony with the Heavens* (2004/05), vol. 1, pp. xii-xiii, n. 14.

This text for **Part I** was prepared with a 2014 "**Mac mini = MacOS Sierra, version 10.12.5 then 10.12.6**" using "**Pages 7.1**" software from **Apple**. The **Pages** software lacks what any author used to appreciate in old-time **MSWord**, for example, the ability to show two parts of the text on the screen at the same time. **Pages** also cannot sort items alphabetically or numerically if they have already been typed; one has to type the text to be sorted into the frame of a table. **Pages** has a pathetically simple "find and replace" action but with **Word** one used to be able to do more useful operations such as italicizing all occurrences of the word 'qibla' or changing the font of selected words together with the replace option. With **Pages** one cannot insert automatic cross-references, which is really annoying in a substantial academic publication. Also, when one is trying to move or modify a selected portion of text, the blacking-out mode tends to jump to a neighbouring part of the original text as one is performing the operation, so that, if one doesn't notice and completes the move or modification, the resulting text can turn out to be gibberish. Whole swathes of text disappeared in this way and had to be reinserted from earlier versions, when possible, otherwise retyped. When dealing with a lengthy text **Pages** also has the annoying habit of inserting unwanted 'vertical' spaces between the bottom of the text and the footnotes. **MSWord** used to do this too: I have been forced to publish books with such spaces since even my publishers could not remove them, and the result was inevitably criticized by reviewers.

The illustrations for **Part II** of this study had to be placed in a separate **Keynote** file because if one puts them in a **Pages** file they jump about uncontrollably. My computer-screen could not be persuaded to show a **Pages** file and a **Keynote** file together on the screen, which was particularly annoying when I was putting references to 250 illustrations in a **Keynote** file into the text of a **Pages** file of 500 pages. I tried to insert three pages of Arabic text, reproduced from my 1984 publication, but each individually wandered all over the surrounding pages. Because of that I retyped all the Arabic, not knowing that I would later have to retype it again.

Responding to an invitation to upgrade the system on my **mac mini** to **macOS** 10.12.6 in July 2019 was a big mistake: the computer was no longer compatible with the screens that I had been using for years in two different locations. In one location I could hook up to an old TV set using an HDMI cable; in the other I spent a week buying two screens, one from **Apple** and then another from the competition **Conrad**. Neither would work, and the **Apple** staff had no idea that (let alone, why) the computer they sold me in 2015 was incompatible with the printer they sold me in 2019. The screen from **Conrad**, half the price of the screen from **Apple**, started to work when my wife noticed on the black frame of the screen a barely-visible black power-switch, a useful feature that I had overlooked for several days (not least because there was no power-switch on the screen sold to me by **Apple**). With both screens functioning once again I was unprepared for what then transpired: a malicious zoom function would, after a few minutes of normal behaviour, enlarge all graphics and internet pages that had been at 100% on the screens to around 400% or thereabouts, offering no means (not even "command" & "-") to reduce them back to 100% except by closing and re-opening the files. The enlarged picture on the screen had a tendency to wander in such a way that the text or the image that I was working on was no longer on the screen at all. With close to 200 images in **Part II** this proved to be not a little annoying.

The **Pages** soft-ware also developed the habit of jumping to an adjacent part of the text being generated. Automatic orthographical corrections were made even when the text was dormant, thus, for example, 'Rabbit' for 'Rabbat' and 'quibble' for 'qibla' appeared overnight and countless distortions of words that were not in English were introduced, such as 'shamble' for 'shamal'. When the footnote count was at around 330, **Pages** developed the annoying habit of not allowing the mouse to access to the texts of the footnotes, so they could not be modified. Clicking frantically 20 times with the mouse was the trick to accessing a given footnote. Or was the problem with **Pages**? The so-called **Magic Mouse 2** of **Apple** – magic is the price at over €80 – had come with totally inadequate instructions and I barely learned how to use it after several months.

Clicking on it the wrong way would eventually make all the sites open on the screen freeze, the only motion coming from an absurd rotating rainbow-coloured disc whose continuous psychedelic rotations signified disaster, forcing me to close down the computer altogether. (This disc is known as the **"The Spinning Beach Ball of Death"**, and antidotes can be found by googling.) I could still not access individual footnotes without hassle, so I purchased a €6.49 **Logitech M100** mouse and found it served precisely the same purposes as the expensive **Apple** mouse and generated less annoyance. If and when this mouse can no longer access the text itself, the latest version will be put online regardless.

After having installed **iCloud** on my computer in the Summer of 2019, and upon pressing a command to send all my data into the aether, there was a kind of soft bang and all the active files on my screen disappeared into the bowels of the computer. Whereas they had previously been organized in folders on the screen, many dozen single files showed up in the DOCUMENTS section, **MSWord** documents separated from **pdfs**, all now without folders. Each of these files could be transferred back to the screen, but only one by one since their folders had disappeared. I dreamed of the old days when one could save something without it scattering, and one could eventually retrieve precisely what one had saved. **iCloud** has apparently developed beyond this.

The annoyingly frequent and seemingly incessant rotations of the **"Spinning Beach Ball of Death"** on the screen which interfere with your typing, inserting, replacing, and saving operations mean that your computer can't continue handling what you are doing. I learned that useful piece of information before I limped toward the completion of this monograph. Before I had finished, however, I checked on the internet for problems with **Pages**. To my dismay but not surprise I found that it is well-known to the savvy that **MSWord** is far superior to **Pages** for long complicated documents. For me, it was, alas, too late to switch to **MSWord** for this monograph. (I had purchased **MSWord** some years ago to handle various other texts but never thought that I should have used it for this one.) I did try to convert the entire text to **MSWord**, but all the footnotes disappeared and all of the Arabic text became jumbled, the

words of each line arranged backwards and the letters of each word also backwards.

Later, in November, 2019, I did indeed transfer the entire text from **Pages** to **MSWord**, managing to save the footnotes and most of the styling, but inevitably the Arabic texts had to be retyped. From then on, **MSWord** crashed every few days and the text had to be salvaged each time. The automatic saving function does not work, and often new text that disappeared just had to retyped. Also, some of the styling – chapter and section headings – had to be frequently reset. Scrolling in the text often resulted in substantial sections being highlighted and then deleted by mistake. Inserting a couple of maps was the ultimate nightmare.

On the other hand, throughout the preparation of some 250 pages of illustrations and commentaries in **Part II**, which were prepared with **Keynote 8.1**, I cannot remember having a single technical problem.

In January, 2020, a young computer wizard told me that these problems are precisely what you would expect with a **mac mini** having only 8 GB of RAM (random access memory), even though some 75% of 1,000 GB space was still were available on the computer. So now I know. It was, of course, too late to try to remedy this situation, for somehow shortly thereafter the text became ready to go, in spite of the **MSWord** file crashing on a daily basis and having to be renamed and resaved. A second computer wizard told me that my problems were caused by the size of the **MSWord** file, but they continued when, for example, I removed the bibliography

It is now May, 2020, and the **SBBD** is more often spinning on the screen than not. It spins interminably at every insertion, deletion, and minor modification to the text. In addition, the styles in the text are volatile, and the save function does not work properly, newly-inserted titles are not picked up by the table of contents function, and lost text required frequent access to previous versions. The search function on **Safari** no longer works, so I cannot easily access the secondary literature on my screen, which I take as a sign that I should stop. **MSWord** crashes on a daily basis, and the file needs to be saved with a different name, and it is then that one

learns that the save function did not work on the previous day, so that yesterdays' changes have to be done again. There is no question of inserting chapter-headings or preparing an index. I beg the reader's indulgence for whatever I am finally able to put up on my academia.edu site.

Part II – Illustrations

Bibliography

> "One's knowledge of valuable tools is never complete, not only because new tools are published almost every year, but also because no matter how diligent a scholar may be there are always some ancient tools which he managed to overlook. I have realized this more than once to my mortification." George Sarton, *A Guide to the History of Science* (1952), p. 74.

Notes: The principal bibliography on the historical aspects of the Cairo wind-catchers is to be found in Rosenthal 1977, King 1984/2004 & Jaubert 1995. Items of particular relevance to the present study are in bold font. Some items may be duplicated in different sections. The literature on wind-catchers in general, particularly those in Iran, is vast, and only a few items are listed below.

There two exist websites **academia.edu** and **researchgate.net**, on which any researcher can upload his/her publications and any interested person can download or access them. The difference between the two sites is quite simple to explain: **academia** offers a sensible, orderly, overseeable, easily accessible platform but charges the author an annual fee, and **researchgate** offers for free a totally chaotic platform, on which neither the author nor the prospective reader has any overview over the materials that have been uploaded and has to search far and wide on the site for articles to download. An increasing number of scholarly articles are uploaded without any indication of their source or date, which does not augur well. Sometimes even the name of the author does not appear, which is not a good idea.

References to these websites where certain publications are available online have not been given systematically; all these websites were accessed during 2019. Some websites deactivated themselves or self-

destructed during the course of preparation of this study. Some web addresses came out normal font, others as hyperlinks. In order not to interfere too much with formatting, website addresses that are absurdly long are sometimes broken down by inserting the combination “—*—” or reducing the font. One can still sometimes access the relevant sites without removing these symbols.

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I: Bio-bibliographical and general works, and dictionaries

Notes: The bio-bibliographical sources for medieval Muslim authors are mainly listed here only by the names of their authors: Carl Brockelmann (general, Arabic); Heinrich Suter (mathematicians & astronomers, Arabic); Max Krause (Istanbul scientific manuscripts); Charles Storey (general, Persian); Fuat Sezgin (authors on all subjects until *ca*. 1050, especially mathematics, astronomy, astrology, geography & cartography); L. A. Mayer (instrument-makers); Boris A. Rosenfeld & Galina Matvievskaya (scientists, general); Ekmeleddin İhsanoğlu *et al*. (scientists, Ottoman period); Boris A. Rosenfeld & Ekmeleddin İhsanoğlu (scientists, general); David A. King (Yemeni astronomical manuscripts & Cairo scientific manuscripts); articles in *Dictionary of Scientific Biography*, *Biographical Encyclopaedia of Astronomers* (entries are much shorter and less useful than the corresponding ones in *DSB*), and *Enc. Islam*, 1st edn., 2nd edn., and maybe 3rd edn. For modern studies of Islamic instruments see *AIOS* and King, *Synchrony*, vol. 2.

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timekeeping and times of prayer)"; "Mizwala (sundials)"; "Rubʿ (quadrant)"; "Nuḏjūm (star-lore)"; "Nuḏjūm, aḥkām al- (astrology)"; "Rīḥ (winds); "Ru'yat al-hilāl (lunar crescent visibility)"; "Shakkāziyya (universal projections)"; "Taḳwīm (ephemeris)"; "Ṭāsa (magnetic compass)"; and "Zīḏj (astronomical handbooks and tables)".

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VII: Orientations

a: Relevant sources on archaeoastronomy and ethnoastronomy

Clive L. N. Ruggles, ed., *Handbook of Archaeoastronomy and Ethnoastronomy*, 3 vols., Dordrecht, *etc.*: Springer Science ..., 2015. A work of monumental importance covering many relevant topics, with various chapters in Part II: Methods and Practices, and overviews by experts on the situation in most parts of the world, although, alas for our present purposes, Central and South Arabia are not covered. The following chapters relate to our subject: David A. King, "Folk astronomy in the service of religion: The case of Islam", pp. 124-138 and "Astronomy in the service of Islam", 181-196; Mònica Rius Piniés, "Qibla in the Mediterranean", pp. 1687-1694; Juan Antonio Belmonte & A. César González-García, "Petra and the Nabataeans", pp. 1813-1822; Clemency Montelle, "Islamic mathematical astronomy", pp. 1909-1916; Tofigh Heidarzadeh, "Islamic astronomical instruments and observatories", pp. 1917-1926; also Clive Ruggles, "Orientation of Egyptian temples: An overview", pp. 1501-1510.

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Amelia Carolina Sparavigna, “Roman towns oriented to sunrise and sunset on solstices”, 2016, at https://papers.ssrn.com/sol3/papers.cfm?abst—*—ract_id=2777118.

– , "Exercises in Archaeoastronomy", 2018, at https://papers.ssrn.com/so—*—l3/papers.cfm?abstract_id=3130602.

b: On the Kaʿba and the early *qibla* (selected)

Note: The literature is vast, but there is, as far as I am aware, no history of the Kaʿba is available.

Alarabiya.net video: "Do you know the names of the four corners of the Kaʿba?", at https://youtu.be/mDGcWU2_adU. (The names seem to have changed since medieval times.)

Reza Assasi, "Kaʿba – a house built under the Sun" (n.d.), 4 pp., at www.aca—*—demia.edu/41324804/.

Wilhelm Barthold, "Die Orientierung der ersten muhammadanischen Moscheen", *Der Islam* 18 (1929): 245-250.

Joseph Chelhod, "A contribution to the problem of the pre-eminence of the right based upon Arabic evidence" (translated from the French), in R. Needham, ed., *Right & Left*, Chicago: University of Chicago Press, 1973, pp. 239-262.

K. A. C. Creswell, "The Kaʿba in A.D. 608", *Archaeologia* 94 (1951): 97-102.

Richard Ettinghausen, "Die bildliche Darstellung der Kaʿba im islamischen Kulturkreis", *Zeitschrift der Deutschen Morgenländischen Gesellschaft* 12 (1933), pp. 111-137. (No diagrams of sacred geography.)

Reuven Firestone, *Journeys in the Holy Lands – The evolution of Abraham-Ishmael legends in Islamic exegesis*, Albany NY: State University of New York, 1990.

Ari Michael Gordon, *Sacred orientation: The Qibla as ritual, metaphor, and identity marker in early Islam,* PhD dissertation 2018, Publicly Accessible Penn Dissertations: 3220, at https://repository.upenn.edu/edissertations/3220.

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Russell King, "The pilgrimage to Mecca: some geographical and historical aspects", *Erdkunde* (Journal of the Geographical Society of Berlin) 26 (1972): 61-73.

Rachel Milstein, "Futuh-i Haramayn: 16th-century illustrations of the Hajj route", in Wasserstein & Ayalon, eds., *Mamluks and Ottomans* (2006), pp. 166-194. (Describes a different kind of Kaʿba representation.)

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Simon O'Meara, "The Kaʿba of New York", in Christiane Kruse & Birgit Meyer & Anne-Marie Korte, eds., *Taking Offense: Religion, Art, and Visual Culture in Plural Configurations*, Paderborn: Fink, 2018, pp. 140-161. (An important article by a distinguished historian, containing several insights on the real Kaʿba (except its orientation).)

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Press, 2020. (The first book to be devoted to the many different aspects of the historical Kaʿba. Not seen yet.)

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Uri Rubin, "The Kaʿba: Aspects of its ritual functions", *Jerusalem Studies in Arabic and Islam* 8 (1986): 97–131.

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Simon Shtober, "*Lā yajūz an yakūn fī al-ʿālam li-Llāhi qiblatayn*: Judaeo-Islamic polemics concerning the qibla (625-1010)", *Medieval Encounters: Jewish, Christian and Muslim Culture in Confluence and Dialogue* 5 (1999), pp. 85-98.

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Richard Kimber, article "Qibla" by in *Encyclopaedia of the Qur'an*, Leiden: Brill, 2005 onwards.

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Mahya Ghouchani & Mohammad Taji & Fatemeh Kordafshari, "The effect of qibla direction on the hierarchy of movement in mosque: A case study of mosques in Yazd, Iran", *Frontiers of Architectural Research*, 2019, at www.sciencedirect.com, (Without reference to any historical *qibla* values for Yazd.)

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– , "The 'Imperious Reasons' that flawed the minaret-flanked setting of Sulṭān Ḥasan's Mausoleum in Cairo – Another note on medieval Cairene on-site planning according to street-alignments and Mecca-orientations", *Damaszener Mitteilungen* (German Archaeological Institute, Damascus) 11 (1999): 307-316

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Ghadeer Dardier Afify Khalifa, “Some Remarks about the Influences of Astronomical Phenomena on Islamic Architecture – Analytical and Applied Study on Selected Religious Architectural Models in Cairo”, *Journal of Historical Archaeology & Anthropological Sciences* 5:2 (2020): 72-85.

David A. King, “Astronomical alignments in medieval Islamic religious architecture”, *Annals of the New York Academy of Sciences* 385 (1982): 303-312, repr. in *idem*, *Astronomy in the service of Islam* (1993), XIII, at www.academia.edu/34682285/, and “The orientation of medieval Islamic religious architecture and cities”, *Journal for the History of Astronomy* 26 (1995), pp. 253-274, at www.academia.edu/34682286/, with a new version in *idem*, *In Synchrony with the Heavens*, vol. 1 (2004), VIIa: 741-771, at www.academia.edu/42922321/.

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Glen Van Brummelen, “The numerical structure of al-Khalīlī’s tables”, *Physis* 28 (1991): 667-697. (A brilliant investigation of al-Khalīlī’s universal auxiliary tables, concluding with suggestions about the way he compiled his universal qibla table.)

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– , “The determination of the sacred direction in Islam”, in *idem*, *World-maps for finding the direction and distance to Mecca*, (1999), ch. 2, pp. 47-127, at www.academia.edu/35883308/.

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– , “The enigmatic orientation of the Grand Mosque of Córdoba”, *Suhayl – International Journal for the History of the Exact and Natural Sciences in Islamic Civilisation* (Barcelona) 16-17 (2018-2019): 33-111, at www.academia.edu/39160124/. (Shows how the suburban Roman street-plan influenced the layout of the Mosque and how later schemes of Islamic sacred geography confirmed that the Mosque was appropriately oriented in a traditional fashion with respect to the NW wall of the Kaʿba. The 2008 preprint at www.academia.edu/35797452/ includes all of the nonsense related about the orientation of the Mosque for over a century.)

– , “Finding the *qibla* by the sun and stars – Islamic sacred geography – a survey of the sources”, 2019, at www.academia.edu/38244518/, also in *Zeitschrift für Geschichte der arabisch-islamischen Wissenschaften* 22 (2020): 1-51.

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Franz Landsberger, “The Sacred Direction in Synagogue and Church”, *Hebrew Union College Annual* (Cincinnati OH) 28 (1957): 181-203.

Mai Lootah, “Science and scripture: How did faith influence cartographic methods used to determine the qibla, the sacred direction of Islam?”, *Spica – Postgraduate Journal for Cosmology in Culture* (Sophia Centre for the Study of Cosmology in Culture – University of Wales Trinity Saint David) 4:2 (2016): 32-59. (A serious popular overview with no technicalities.)

Stephen C. McCluskey, “Orientation of Christian Churches”, in Clive Ruggles*, A Handbook of Archaeoastronomy and Ethnoastronomy* (2015), pp. 1703-1710.

Konrad Miller, *Mappæ arabicæ; Arabische Welt- und Landerkarten*, V. Band:

Weltkarten, Stuttgart, 1931. (Contains first indication of the existence of Islamic diagrams of sacred geography.)

Mònica Rius Piniés, *La Alquibla en al-Andalus y al-Magrib al-Aqsà*, Barcelona: Institut "Millás Vallicrosa" de Història de la Ciència Àrab, 2000. (The first investigation of mosque orientations in al-Andalus and the Maghrib in the light of medieval folk astronomical and legal texts on the *qibla.*)

Fuad Safar, *Wāsiṭ, the sixth season's excavations*, Cairo: Institut Français d'Archéologie orientale, 1945. (Not seen.)

Tono Saksono & Mohamad Ali Fulazzaky & Zamah Sari, "Geodetic analysis of disputed accurate *qibla* direction", *Journal of Applied Geodesy* 12 (2018): 129-138.

George Sarton, "Query: Orientation of the mihrab in mosques", *Isis* 20 (1933): 262-264, see also *ibid*., 24 (1935): 109-11; 34 (1942): 2; 35 (1944): 176; & 38 (1947): 95-96.

Petra G. Schmidl, *Volkstümliche Astronomie im islamischen Mittelalter. Zur Bestimmung der Gebetszeiten und der Qibla bei al-Asbahī, Ibn Rahīq und al-Fārisī*, (Islamic Philosophy, Theology and Science – Texts and Studies, vol. LXVIII), 2 vols., Leiden, *etc*.: Brill, 2007. (The first study of its kind, based on medieval Yemeni treatises on folk astronomy compiled by legal scholars and astronomers.)

– , "Zur Bestimmung der Qibla mittels der Winde", in Peter Eisenhardt, Frank Linhard and Kaiser Petanides, eds., *Der Weg der Wahrheit – Aufsätze zur Einheit der Wissenschaftsgeschichte. Festgabe zum 60. Geburtstag von Walter G. Saltzer*, Hildesheim: Georg Olms, 1999, pp. 135-146.

– & Mónica Herrera Casais, "The earliest known schemes of Islamic sacred geography", in A. Akasoy & W. Raven, eds., *Islamic thought in the Middle Ages: Studies in text, transmission and translation in honour of Hans Daiber*, (Islamic Philosophy, Theology and Science – Texts and Studies, vol. LXXV), Leiden: Brill, 2008, pp. 275-300. (Detailed investigations of schemes by Ibn Khurradādhbeh & Pseudo-al-Muqaddisī.)

Lucy Seton-Watson, *The development of the Darb al-Ahmar, Cairo, 969-1517*, unpublished M.A. thesis, American University in Cairo, 2000.

Burkhard Stautz, "Sterne, Winde und Gebete – Islamische Instrumente", in *Faszination Orient – Max von Oppenheim – Forscher ◦ Sammler ◦ Diplomat*, Gabriele Teichmann and Gisela Völger, eds., Cologne: DuMont, 2001, pp. 372-381 (A); and the complete version in *Sterne, Winde und Gebete – Max von*

Oppenheims islamische Instrumente, Hünfelden-Dauborn (D): Al-Daburnaha-Verlag, 2002 (B).

Krisztina Szilágyi, "Cardinal directions (Islam)" in *Encyclopedia of the Bible and its Reception*, Berlin/New York: Walter de Gruyter, vol. 6 (date?)

H. Masud Taj, "Facing the city: the influence of qibla on street-line orientation in Islamic cities", *Proceedings of Symposium on Mosque Architecture, College of Architecture & Planning, King Saud University, 1419H-1999*, 38 (1999): 173-181.

Glen Van Brummelen, "The numerical structure of al-Khalīlī's tables", *Physis* 28 (1991): 667-697. (A brilliant investigation of al-Khalīlī's universal auxiliary tables, concluding with suggestions about the way he compiled his universal qibla table.)

– , "Seeking the Divine on Earth: The direction of prayer in Islam", *Math Horizons* 21:1 (Sept. 2013): 15-17.

Yehia Hasan Wazeri, "Exploring the significance of Mecca Sacred Mosque global location", *Journal of Islamic Architecture* 4 (2017): 86-92.

Mustafa Yilmaz & Ibrahim Tiryakioglu, "The astronomical orientation of the historical Grand Mosques in Anatolia (Turkey)", *Archive for History of Exact Sciences* 72 (2018): 565–590, at www.researchgate.net/publication/327702943.

Mohamed Zakariya, "The trouble with the Qibla", at https://mohamed—*—zakariya.com/essays/the-trouble-with-the-qibla/ (n.d.).

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M. Z. Ibrahim & M. Z. Norashikin, "Universal qibla and prayer time finder", *World Academy of Science, Engineering and Technology* 58 (2009): 447-452. (No historical information, no indication of 1,000 years of universal qibla and prayer time finders).

VIII: Modern technical or environmental studies on wind-catchers (A)

Note: None of the following authors were/are aware of the available documentation on medieval wind-catchers of medieval or pre-modern Cairo, this in spite of some fairly promising titles.

a: Hassan Fathy

Hassan Fathy, *Natural energy and vernacular architecture – Principles and examples with reference to hot arid climates*, Walter Shearer & Abd-el-rahman Ahmed Sultan, eds., Chicago & London: The University of Chicago Press, published for The United Nations University, 1956, at http://archive.unu.edu/unupress/unupbooks/80a01e/80A01E00.htm, especially http://archive.unu.edu/unupress/unupbooks/80a01e/80A01E08.htm#The%20b%EF%BF%BDDdgir (the new UNU site http://unu.edu seems to have dropped this book).

Khaled A. Al-Sallal & Meriem Rahman, "Vernacular architecture in the Middle East & North Africa region: review of bioclimatic strategies and analysis of case studies", in Ali Sayigh, ed., *Sustainable vernacular architecture – How the past can enrich the future*, Cham CH: Springer Nature Switzerland AG, 2019, pp. 23-54, at www.researchgate.net/publication/332074566 (see especially pp. 40-49 on case studies from the Gulf, Sanaa, and Cairo (based of Fathy)).

Leïla El-Wakil, "Hassan Fathy and traditional/vernacular architecture", at www.academia.edu/9303279/.

– , "Présentation du Conte du moucharabieh (Qisat [*sic*] al-mashrabiyya) – Enraciner l'architecture appropriée : Hassan Fathy", in Mercedes Volait & Emmanuelle Perrin, eds., *Dialogues artistiques avec les passés de l'Égypte – Une perspective transnationale et transmédiale*, Paris: Publications de l'Institut national d'histoire de l'art, 2017, pp. 133-142.

Salma Samar Damluji & Viola Bertini, *Hassan Fathy – Earth & Utopia*, Laurence King Publishers, 2018. See also Harriet Thorpe, "The first book on the philosophy and work of Egyptian architect Hassan Fathy", *Architecture* 9 Oct 2018, at www.wallpaper.com/architecture/hassan-fathy-book-laurence-king.

Panayiota Pyla, "Hassan Fathy revisited: Postwar discourses on science, development, and vernacular architecture", *Journal of Architectural Education* 60 (2007): 28-39.

James Steele, *Hassan Fathy*, London: Academy Editions, & New York: St. Martin's Press, 1988.

– , *An Architecture for People: The Complete Works of Hassan Fathy* New York: Whitney Library of Design, 1997. (Not seen.)

Mohamed Mostafa Mahdy, *Applying architecture simulation tools to assess building sustainable design: Adapting the Egyptian residential energy code for climate change*, doctoral thesis, University of Kent, 2014.

Hana Taragan, "Architecture in fact and fiction: The case of the New Gourna village in Upper Egypt", *Muqarnas* 16 (1999): 169-178, at www.academia.edu/—*—19499123/.

b: Susan Roaf

Susan Roaf, *The Windcatchers of Yazd*, Ph.D. dissertation, Oxford Polytechnic, 1989.

– , “Windcatchers”, in *Living with the Desert*, E. Beazley & M. Harverson, eds., Liverpool: Aris and Phillips, 1982, pp. 57-70, accessible *via* www.resea—*—rchgate.net/publication/273406388.

– , “Windcatchers in the Middle East,” *Islamic Architecture and Urbanism*, selected papers from a symposium organized by the College of Architecture and Planning, King Faisal University, Dammam, 1983, pp. 257-68.

– , article “Bādgīr” in *Encyclopaedia Iranica* (III:4, pp. 368-370) (1988), at www.iranicaonline.org/articles/badgir-traditional-structure-for-passive-air-conditioning.

– , “The traditional technological trap: Stereo-type of Middle Eastern traditional building types and technologies”, *TRIALOG – Zeitschrift für das Planen und Bauen in der Dritten Welt* 25 (1990): 26–33.

– , “Sustainable Buildings: Middle Eastern Traditional Systems for the Future”, inTapper & McLachlan, eds., *Technology, Tradition and Survival – Aspects of Material Culture in the Middle East and Central Asia* (2003), pp. 86-97.

– , “Air-conditioning avoidance: lessons from the windcatchers of Iran”, *Proceedings of an International Conference “Passive and Low Energy Cooling for the Built Environment”, May 2005, Santorini, Greece*, pp. 1053-1057, at www.academia.edu/3490916/.

– , “739: The Traditional Technology Trap (2): More lessons from the Windcatchers of Yazd”, *PLEA 2008 – 25th Conference on Passive and Low Energy Architecture* (Dublin, 22-24 October 2008), pp. 1-5, at www.academia.edu/3490907/.

Ciaran McCabe a & Susan Roaf, “The wind towers of Bastakiya: assessing the role of the towers in the whole house ventilation system using dynamic thermal modelling”, *Architectural Science Review* (2012): 1-12.

c: Mahdi Bahadori (selected) & Alireza Dehghani-sanij

Mehdi N. Bahadori, “Passive cooling systems in Iranian architecture”, *Scientific American* 238:2 (February 1978): 144-154.

Mehdi N. Bahadori & Alireza Dehghani-sanij, *Wind Towers: Architecture, Climate and Sustainability*, (series edited by Ali Sayigh), Cham CH, *etc*.: Springer International Publishing Switzerland, 2014. (Contains an important chapter on the history of the *bādgīr*, mentioning the poetry on the Egyptian *bādahanj*.)

A. R. Dehghani-sanij & M. Soltani & K. Raahemifar, "A new design of wind tower for passive ventilation in buildings to reduce energy consumption in windy regions", *Renewable and sustainable energy reviews* 42 (2015): 182-195, at www.sciencedirect.com/science/article/pii/S1364032114008351.

d: Olivier Jaubert

Olivier Jaubert, "Capteurs de vents d'Égypte. Essai de typologie", *Annales islamologiques* 29 (1995): 169-231, at www.ifao.egnet.net—*—/anisl/029/09/.

Note: Olivier Jaubert kindly provided me with his unpublished research reports on ventilation techniques in the various parts of Near East and beyond. These are as follows:

Olivier Jaubert, Central Asia Research Report: Rapport d'activité, Bourse de l'Institut français d'études sur l'Asie Centrale (IFEAC), mars-septembre 1996.

– , Egypt Research Report: Rapport d'actvité, Bourse Institut français d'ārchéologie orientale (IFAO), février 1996 et mars 1997.

– , Iran Research Report, 1997: Rapport d'activité, Bourse Lavoisier du Ministre des Affaires Étrangères, Institut français d'études sur l'Iran, Téhéran, avril-mai 1997.

– , Architectural plans, Iran: Cahier de croquis, Iran 2005.

e: Yehia Wazeri

Yehia Hasan Wazeri, *The Natural Cooling Systems – An approach for improving the thermal performance of buildings in North Africa*, PhD thesis, Cairo University, Institute of African Research and Studies, Department of Natural Resources, 2001.

– , العمارة الاسلامية والبيئة(Islamic architecture and the environment), عالم المعرفة (The World of Knowledge), no. 304, Kuwait, June 2004 (includes a general discussion of *malqaf*s with mention of those on the Sinnārī and Suḥaymī houses).

– , العمارة والفلك - تأثير الظواهر الفلكية على مباني الحضارات القديمة (*Architecture and astronomy*

– *the influence of astronomical phenomena on buildings in ancient civilizations*), Cairo: Maktabat ʿĀlam al-kutub, 2013. (The only Arabic source known to me discussing the orientation of the Kaʿba.)

– , العمارة الاسلامية - نظرة عصرية, (Islamic architecture - a modern look)", Center of Planning and Architectural Studies (www.cpas-egypt.com), Cairo, n.d.

IX: Modern technical or environmental studies on wind-catchers (B)

Note: This is a selection of well over 100 books and articles on wind-towers mainly in Iran and the Gulf region together with vernacular architecture elsewhere. The items listed here are not in any order. No attempt has been made to evaluate them. In particular, no attempt has been made to make this list exhaustive: some 3,000-odd studies with title or text containing the word 'wind-catcher' can be found using the search engine of www.academia.edu.

None of these books and articles contain any historical information of consequence on the Cairo wind-catchers, and most do not even mention them.

Daniel Dunham, "The courtyard house as a temperature regulator", *The New Scientist* 04.09.1960, pp. 663-666.

Brian Ford & Nimish Patel & Parul Zaveri & Mark Hewitt, "Cooling without air conditioning: The Torrent Research Centre, Ahmedabad, India", *Renewable Energy* 15 (1998): 177-182, at www.sciencedirect.com/science/artic—*—le/abs/pii/S0960148198001505.

Olivier Rey, "Windcatcher could save billion dollars a year in home cooling", *Red Dirt Report* (Oklahoma), 16.03.2016, at www.reddirtreport.com/slice-o-life/windcatcher-could-save-billion-dollars-year-home-cooling.

Khaled Selim Vajal, "Developing Malqaf al-Hawa' in order to be used in contemporary Egyptian architecture", Master's thesis, Faculty of Engineering, Minia University, date? (unavailable).

Imad Ajwa, "Architectural solutions treatment of the phenomena of climate architecture Cairo since its inception until the end of the Ottoman era" (in Arabic), Doctoral thesis, Faculty of Archaeology, Cairo (?), date? (unavailable).

Sarinaz Suleiman & B. Himmo, "Direct comfort ventilation: Wisdom of the Past and technology of the Future (wind-catcher)", *Sustainable Cities and Society* 5 (2012): 8-15, at www.researchgate.net/publication/271638642.

Hanan S. Saleh & Salah Z. Saied, "Green architecture as a concept of historic Cairo",

(International Conference – Green Urbanism, GU 2016), *Procedia Environmental Sciences* 37 (2017): 342-355, at www.sciencedirect.com.

Abbas M. Hassan & Hyowon Lee & Uoosang Yoo, "From medieval Cairo to modern Masdar City: Lessons learned through a comparative study", *Architectural Science Review* 59 (2015): 1-14, available from www.researchgate.net/p—*—ublication/276703027.

Mohamed Mostafa Mahdy, *Applying architecture simulation tools to assess building sustainable design: Adapting the Egyptian residential energy code for climate change*, doctoral thesis, University of Kent, 2014.

Ahmed Sedky, "The factors influencing the change in Cairene domestic architecture after the Ottoman conquest", *Electronic Journal of Islamic Studies* 4 (no. 38) (2001): 1-23, at www.academia.edu/558991/.

– , *Living with Heritage in Cairo – Area conservation in the Arab-Islamic city*, Cairo: American University of Cairo Press, 2009.

Mehdi N. Bahadori, "Passive cooling systems in Iranian architecture", *Scientific American* 238:2 (February 1978): 144-154.

Berlin 2019 Conference: International Conference / Vernacular architecture as frame of life in historic and ancient communities, Berlin, 4-7 April 2019 – see https://eahn.org/app/uploads/2019/02/Vernacular-Architecture-TUB_DAIK_Preliminary_Programm.pdf (no papers on Cairene architecture).

A. R. Dehghani-sanij & M. Soltani & K. Raahemifar, "A new design of wind tower for passive ventilation in buildings to reduce energy consumption in windy regions", *Renewable and sustainable energy reviews* 42 (2015): 182-195, at www.sciencedirect.com/science/article/pii/S1364032114008351.

Alex Kalmikov & Katherine Dykes, "Wind Power Fundamentals", MIT Wind Energy & Renewable Energy Projects in Action, wind@mit.edu.

Rafik Bensalem, *Wind-driven natural ventilation in courtyard and atrium-type buildings*, Ph.D. thesis, School of Architectural Studies, University of Sheffield, 1991, at http://etheses.whiterose.ac.uk/3000/1/DX197102.pdf.

Brian Edwards & Magda Sibley & Mohammad Hakmi & Peter Land, eds., *Courtyard Housing – Past, Present and Future*, Abingdon: Taylor & Francis, 2006, at www.academia.edu/12290858/. (Deals with the situation in numerous countries, but not Egypt.)

Chinmoy Mitra, *Site planning for natural ventilative cooling in urban areas within a warm humid climatic zone*, Master of Architecture thesis, University of Arizona, Tucson, 1984, at https://repository.arizona.edu/bitstream/handle/101–

–*—50/555372/AZU_TD_BOX354_YARP_1013.pdf?sequ—*—ence=1&isAllowed=y.

Mohamed Ahmed Fouad Hassan Mahdy, "Vernacular urbanism in hot arid climate zones in Egypt and the challenges of Climate Change" (2018), at https://www.researchgate.net/publication/322686343_Vernacular_Urbanism_in_Hot_Arid_Climate_Zones_in_Egypt_and_the_Challenges_of_Climate_Change/figures?lo=1.

Ayman Al Suliman, "Wind catchers and sustainable architecture in the Arab World", *Civil and Environmental Research* 6:12 (2014), at www.research—*—gate.net/publication/297026118.

Mohamadjavad Mahdavinejad & Kavan Javanroodi, "Natural ventilation performance of ancient wind catchers, an experimental and analytical study – case studies: one-sided, two-sided and four-sided wind catchers", *International Journal of Energy Technology and Policy* 10:1 (2014): 36-60, at www.researchgate.net/publication/287337941

Gholamhossein Memarian & Frank Brown, "The shared characteristics of Iranian and Arab courtyard houses", in Edwards & Sibley & Hakmi & Land, eds., *Courtyard Housing – Past, Present and Future* (2006), pp. 27-40, at www.academia.edu/12290858/. (Deals with houses in Iran and Iraq.)

Mahmoud Tavassoli, *Urban Structure in Hot Arid Environments: Strategies for Sustainable Development*, Cham CH: Springer International Publishing Switzerland, 2016. (Deals only with Iran.)

Ahmed Abdel Wahab Ahmed Rizk & Mohamed Abdel Mawgoud Abdel Ghaffar, "The effect of wind-catchers (*al-malaqef*) on the internal natural ventilation in hot climates with special reference to Egypt", *Ass. Univ. Bull. Environ. Res.* 10 (2007): 1-12, at www.aun.edu.eg/env_enc/march2007/1-12(end).doc.

Abdullateef M. Khedher & Abbas S. Hussein, "Simulation for the buildings ventilation using windcatchers in Mosul" (2015) (in Arabic), source not stated, pp. 42-52, at www.iasj.net/iasj?func=fulltext&aId=101546.

H. Montazeri & F. Montazeri, "CFD simulation of cross-ventilation in buildings using rooftop wind-catchers: Impact of outlet openings", *Renewable Energy* 118 (April 2018): 502-520, at www.sciencedirect.com/science/art—*—icle/pii/S0960148117311321 (bibliography of over 100 items, all technical).

Hossam El-Borombaly & Luis Fernando Molina-Prieto, "Adaptation of vernacular designs for contemporary sustainable architecture in Middle East and Neotropical Region", *International Journal of Computer Science and*

Information Technology Research 3:4 (2015): 13-26, at www.research—*—gate.net/publication/282660639.

Sultan Alfraidi & Rabah Boukhanouf & Aasem Alabdullatief & Abdulrahman Alharbi & Hatem Ibrahim & Turki Habeebullah, "Cool minaret: a functional element of passive cooling for mosques in hot-arid climates", *The First International Conference on Mosque Architecture* (Papers from 2016 Conference in Dammam, KSA), pp. 155-172.

C. W. Guest, "More than just hot air – Using traditional Arabic wind towers could have huge energy savings", *Construction Week* 19.01.2014, at www.constructionweekonline.com/article-25998-more-than-just-hot-air.

Nick Ames, "Wind towers stage a comeback", *Middle East Architect* 30.01.2014, at www.middleeastarchitect.com/insight/wind-towers-stage-a-comeback.

Yasmine El Deeb & Inji Kenawy, "Revival of traditional Islamic architectural principles", *2nd International Conference on Sustainability and the Future: Egypt, May 2016*, at www.researchgate.net/publication/303446070.

Samer Kallas, *The change of Damascus*, Master of Architecture thesis, School of Architecture, University of Colorado at Denver, 1988,

Maha Sabah Salman Al-Zubaidi, *The sustainability potential of traditional architecture in the Arab world, with reference to domestic buildings in the UAE*, Doctoral thesis, University of Huddersfield, 2007, at http://eprints.h—*—ud.ac.uk/id/eprint/965/.

Azadeh N. Ashtiani, *Creating shade in arid climates: A welcoming landscape based on Zoroastrian beliefs for the Towers of Silence*, Master of Landscape Architecture thesis, Virginia Polytechnic Institute and State University, Alexandria VA, 2019.

Omar S. M. Asfour, *Ventilation characteristics of buildings incorporating different configurations of curved roofs and wind catchers (with reference to human thermal comfort)*, Doctoral thesis, University of Nottingham, School of the Built Environment Institute of Architecture, 2006, at http://eprints.notting—*––ham.ac.uk/56210/1/PHD_Omar%20Asfour.pdf.

Abbas M. Hassan & Hyowon Lee & Uoosang Yoo, "From medieval Cairo to modern Masdar City: Lessons learned through a comparative study", *Architectural Science Review* 59 (2015): 1-14, at www.researchgate.net/publication/—*—276703027 .

Mohammad Bahramzadeh & Bahador Sadeghi & S. Sabok Rou, "Identifying the identity of Iranian wind catchers and their types", *Journal of Basic and Applied*

Scientific Research “3(2s)” (2013): 12-19, at www.textroad.com/pdf/J—*—BASR/J.%20Basic.%20Appl.%20Sci.%20Res.,%203(2s)12-19,%202013.pdf.

– & – & – , “A comparative study to compare the wind catcher types in the architecture of Islamic countries”, *Journal of Basic and Applied Scientific Research* 3 (2013): 312-316, at www.textroad.com/pdf/JBASR/J.%20B—*—asic.%20Appl.%20Sci.%20Res.,%203(2s)312-316,%202013.pdf (mentions wind-catchers in Egypt and Iraq).

Reem Abdelkader & Jin-Ho Park, “Spatial principles of traditional Cairene courtyard houses in Cairo”, *Journal of Asian Architecture and Building Engineering* 17:2 (2018): 245-252, at www.tandfonline.com/doi/pdf/10.3130/jaabe.17.245.

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XI: Historical mosque orientations misunderstood

Note: Some modern revisionists believe that one can come to meaningful historical conclusions by comparing historical mosque orientations with (irrelevant modern) directions. The naïve and uninformed writings of Patricia Crone & Michael Cook on mosque orientations have resulted in much confusion in the modern scholarly literature and are ultimately responsible for the crank literature seeking to rewrite early Islamic history using the orientations of historical mosques. They have already the distinct advantage that they talk only of one *qibla* for each location under consideration, namely, the modern one, which all moderns can understand, and easily show that early mosques do not face these directions. Of course, historical mosques cannot be expected to be oriented in the modern *qibla*s. But the ultimate purpose of these cranks is to revise Islamic history according to their own interests, and they started out on their venture and continue on it happily ignoring what Muslim scholars wrote on the *qibla* during more than a millennium, as well as all that has been written on the *qibla* by Western scholars over the past century. They can be expected to continue to use the fact that “historical mosques do not face Mecca” to their own advantage.

Dan Gibson

Juan Antonio Belmonte & Antonio César & González-García & Andrea Rodríguez-Antón & María Antonia Perera Betancor, “Equinox in Petra: Land and Skyscape in the Nabataean Capital”, *Nexus Network Journal* / 22 (2020): 369-

391. (Reveals the astronomical alignments in Petra before Gibson's imaginary Muslims spread out from Petra to all corners of the world and calculated (!) the *pibla* to Petra, aligning the earliest mosques, according to him, exactly toward Petra. The four authors here are, of course, innocent of the nonsense generated by Gibson.)

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Mark Anderson, “Is Petra Islam’s true birthplace—or Mecca?”, at https://understandingislam.today/ui3/wp-content/uploads/2018/09/Is_Petra_Islams_true_birthplace.pdf. (**This should be required reading for anyone interested in the subject.** Unfortunately, DAK is reported to have said that the earliest Muslims “calculated” the *qibla* but this is what Gibson falsely claims for directions to Petra. In fact, I had stated that they “determined” the *qibla* toward the Kaʿba; they calculated nothing.)

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Jay Smith, “Examining the newest historical research on Islam and the earliest Quranic manuscripts”, presentation at Forum of Christian Leaders, 22.12.2016, www.youtube.com/watch?v=fMJRsd8SrhU. (Contains much talk about Gibson’s findings about the orientations of early mosques, but neither Gibson nor Smith has any understanding of the ways in which Muslims determined the *qibla* in the first centuries of Islam or thereafter.)

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the Kaʿba, even though they – not surprisingly – do not face the modern direction of Mecca.)

Robert M. Kerr

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XII: Miscellaneous writings on climate change (selected)

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